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TO his much honoured Friends, *Manwaring Davies* of the *Inner Temple*, Esq; and Mr. *Humphry Davies* of St. *Mary Newington Butts*, in the County of *Surry*.

John Hawkins, as an Acknowledgment of unmerited Favours, humbly dedicateth this *Manual of Arithmetic*.

To the READER.

Courteous Reader,

I Having had the Happiness of an intimate Acquaintance with Mr. *Cocker* in his Life-time, often sollicited him to remember his Promise to the World, of publishing his *Arithmetick*; but (for Reasons best known to himself) he refused it; and after his Death (the Copy falling accidentally into my Hand) I thought it not convenient to smother a Work of so considerable a Moment, not questioning but it might be as kindly accepted as if it had been presented by his own Hand. The Method is familiar and easy, discovering as well the Theoric as the Practic of that necessary Art of *Vulgar Arithmetic*. And in this new Edition there are many remarkable Alterations for the Benefit of the Teacher or Learner, which I hope will be very acceptable to the World. I have also performed my Promise, in publishing the *Decimal Arithmetick*, which finds Encouragement to my Expectation, and the Booksellers too. I am thine to serve thee,

John Hawkins.

Mr.

Mr. Edward Cocker's

PROEM or PREFACE.

BY the secret Influence of Divine Providence, I have been instrumental to the Benefit of many, by Vertue of those useful Arts, Writing *and* Engraving: *And do now with the same wonted Alacrity cast this my Arithmetical Mite into the publick Treasury, beseeching the Almighty to to grant the like Blessing to these as to my former Labours.*

Seven Sciences supremely excellent,
Are the chief Stars in *Wisdom*'s Firmament:
Whereof *Arithmetick* is one, whose Worth
The Beams of Profit and Delight shine forth;
This crowns the rest, this makes Man's Mind compleat,
This treats of Numbers, and of this we treat.

I have been often desired, by my intimate Friends, to publish something on this Subject, who, in a pleasing Freedom, have signified to me, that they expected it would be extraordinary. How far I have answered their Expectation I know not; but this I know, that I have desig ed this Work not extraordinary abstruse or profound, but have, by all Means possible, within the Circumference of my Capacity, endeavoured to render it extraordinary useful to all those, whose Occasions shall induce them to make use of Numbers. *If it be objected, That the Books already published, treating of* Numbers, *are innumerable; I answer, That's but a small Wonder, since the Art is infinite. But that there should be so many excellent Tracts of* Practical Arithmetick *extant, and so little practised, is to me a great Wonder; knowing, that as* Merchandize *is the Life of the Weal publick, so* Practical Arithmetick *is the Soul of* Merchandize. *Therefore I do ingenuously profess, that in the Beginning of this Undertaking, the numerous Concerns of the honoured*

Merchant first possesseth my Consideration: And how far I have accommodated this Composure for his most worthy Service, let his own profitable Experience judge.

Secondly, *For your Service, most excellent Professors, whose Understandings soar to the Sublimity of the Theory and Practice of this noble Science, was this Arithmetical Tractate composed; which you may please to employ as a Monitor to instruct your young* Tyroes, *and thereby take Occasion to reserve your precious Moments, which might be exhausted that Way, for your more important Affairs.*

Thirdly, *For you the ingenious Offspring of happy Parents, who will willingly pay the full Price of Industry and Exercise for those Arts and choice Accomplishments, which may contribute to the Felicity of your future State: For you, I say, (ingenious Practitioners) was this Work composed, which may prove the Pleasure of your Youth, and the Glory of your Age.*

Lastly, *For you the pretended Numerists of this vapouring Age, who are more disingeniously witty to propound unnecessary Questions, than ingenuously judicious to resolve such as are necessary; for you was this Book composed and published, if you will deny yourselves so much as not to invert the Streams of your Ingenuity, but by studiously conferring with the Notes, Names, Orders, Progress, Species, Properties, Proprieties, Proportions, Powers, Affections and Applications of* Numbers *delivered herein, become such Artists indeed as you now only now seem to be. This* Arithmetick, *ingeniously observed and diligently practised, will turn to good account to all that shall be concerned in Accompts, since all its Rules are grounded on Verity, and delivered with Sincerity; the Examples built up gradually from the smallest Consideration to the greatest; and all the Problems or Propositions well weighed, pertinent and clear, and not one of them throughout the Tract taken upon Trust, therefore, now,*

> *Zoilus* and *Momus*, lie you down and die,
> For these Inventions your whole Force defy.

Edward Cocker.

Courteous Reader,

BEing well acquainted with the deceased Author, and finding him knowing and studious in the Mysteries of Numbers and Algebra, of which he had some choice Manuscripts, and a great Collection of printed Authors in several Languages, I doubt not but he hath writ his Arithmetick suitable to his own Preface, and worthy Acceptation, which I thought fit to certify, on a Request to that Purpose, made to him that wisheth thy Welfare, and the Progress of Arts.

Nov. 27, 1677. *John Collens.*

This Manual of Arithmetick *is recommended to the World by us whose Names are subscribed*, viz.

Mr. John Collens, *Math.*	*Mr.* William Mason
Mr. James Atkinson, *Math.*	*Mr.* Stephen Thomas
Mr. Peter Perkins, *Math.*	*Mr.* Peter Storey
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	Mr. John Hawkins

And generally approved by all ingenious Artists.

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CHAP. I.

Notation of Numbers.

ARITHMETICK is an Art of Numbering or Knowledge, which teacheth to number well. And there are divers Species and Kinds of *Arithmetick* and *Geometry*, the which we do intend to treat of in Order, applying the Principles of the one to the Definition of the other. For as Greatneſs is the Subject of *Geometry*, ſo Number is the ſubject of *Arithmetick*; and if ſo, then their firſt Principles and chief Fundamentals muſt have like Definitions, or at leaſt ſome Congruency.

2. Number is that by which the Quantity of any thing is expreſſed or numbered; as the Unit is the Number by which the Quantity of one Thing is expreſſed or ſaid to be one, and two, by which it is named two, and $\frac{1}{2}$ half, by which it is named or called half, and $\sqrt{3}$ the Root of 3, by which it is called the Root of 3; the like of any other.

3. Hence it is that Unit is Number; for the Part is of the ſame Matter that is his Whole, the Unit is part of the Multitude of Units, therefore the Unit is of the ſame Matter, that is the Multitude of Units; but the Matter of the Multitude of Units is Number; therefore the Matter of Unit is Number; for elſe, if from a Number given no Number be ſubtracted, the Number given remaineth; as ſuppoſe 3 the given Number, if, as ſome ſuppoſe, 1 be no Number, then if you ſubtract 1 from 3, there muſt remain three ſtill; which is very abſurd.

4. Hence it will be convenient to examine from whence Number hath its Riſe or Beginning. Moſt Authors maintain, that Unit is the Beginning of Number, and itſelf no Number; but looking upon the Principles and Definitions in the firſt Rudiments of Geometry, we ſhall find that the Definition of a Point is no way congruous with the Definition of an Unit in Arithmetick; and therefore One or Unit muſt be in the Bounds or Limits of Number, and conſequently the Beginning of Number is not to be found in the Number 1; wherefore making Number and Magnitude congruent in Principles, and like in Definitions, we make

and constitute a Cypher to be the Beginning of Number, or rather the Medium between encreasing and decreasing Numbers, commonly called absolute or whole Numbers, and negative and fractional Numbers, between *which* nothing can be imagined more *agreeable* to the Definition of a Point in Geometry; for as a Point is an Adjunct of Line, and itself no Line, so is a (o) Cypher an Adjunct of Number, and itself no Number: And as a Point in Geometry cannot be divided or increased into Parts, so likewise (o) cannot be divided or increased into Parts; for as many Points, tho' in Number infinite, do make no Line, so many (o) Cyphers, tho' in Number infinite, do make no Number. For the Line A B cannot be increased by the Addition of the Point C, neither the Number D be increased by the Addition of the (o) Cypher E; for if you add nothing to 6, the Sum will be 6, (o) Cypher neither increasing nor diminishing the Number 6; but if it be granted, that A B be extended or prolonged to the Point C, so that A C be made a continued Line, then A B is increased by the Addition of the Point C. In like manner, if we grant D (6) to be prolonged to E (o), so that D E (60) be a continued Number, making 60, then (6) is augmented by the Aid of (o) as constituting the Number (60) Sixty: And furthermore, that 1 or Unit is material, and a Number, and that (o) is the Beginning of Number, is proved by all Authors, altho' indirectly; for the Tables of Sines and Tangents prove one Degree to be a Number, because the Sine of 1 Degree is 174524, (the Radius being 1000000) and the Beginning of the Table is (o), and it answereth oooooo, &c.

A——B
C
D 6
E o
——
Sum of 6

A-B-C

D E | 06
6 o |

5. Hence it is that Number is not Quantity discontinu'd, for that which is but one Quantity, is not Quantity disjunct: (60) Sixty, as it is a Number, is one Quantity, *viz.* one Number (60) sixty; therefore as it is a Number, it is not Quantity disjunct, for Number is some such Thing in Magnitude, as Humidity in Water; for as Humidity extends itself thro' all and every part of Water, so Number related to Magnitude doth extend itself thro' all and every part of Magnitude: Also, as continued Water doth answer continued Humidity, so to a continued Magnitude doth answer a continued Number. As the continued Humidity of an intire Water suffereth the same Division and Distinction that his Water doth, so the continued Number suffereth the same Division and Distinction that his Magnitude doth.

doth. And thus much concerning the Definition and Principles of Number and Magnitude. We come now to treat of,

6. The Characters or Notes by which Numbers are signified, or by which a Number is ordinarily expressed; and they are these, *viz.* (0) Cypher or Nothing, 1 One, 2 Two, 3 Three, 4 Four, 5 Five, 6 Six, 7 Seven, 8 Eight, 9 Nine. The Cypher, which tho' of itself it expresseth not any certain or known Quantity, yet is the Beginning or Root of Number, and the other nine Figures are called significant Figures or Digits.

7. In Number of any Sort two Things are to be considered, *viz.* *Notation* and *Numeration.*

8. *Notation* teacheth how to describe any Number by certain Notes and Characters, and to declare the Value thereof, being so described, that is by Degrees and Periods.

9. A Degree consists of 3 Figures, *viz.* of three Places, comprehending Units, Tens and Hundreds, so 365 is a Degree, and the first Figure (5) on the right Hand, stands simply for its own Value, being Units, or so many Ones, *viz.* five; the second in Order from the Right, signifies as many times Ten as there are Units contained in it, *viz.* sixty; the third in the same Order signifies so many Hundreds as it contains Units, so will the Expression of the Number be Three hundred sixty five, *&c.*

10. A Period is when a Number consists of more than 3 Figures or Places, and whose proper Order is to prick every third Place, beginning at the right Hand, and so on to the left; so the Number 63452 being given, it will be distinguished thus, 63,452, and expressed thus, sixty three thousand four hundred fifty two; likewise 4,578,236,782, being distinguished as you see, will be expressed thus, four thousand five hundred seventy eight millions, two hundred thirty six thousand, seven hundred eighty two,

11. Number is either Absolute or Negative.

12. Absolute, intire, whole, increasing Number, is that by which annexing another Figure or Cypher, it becomes ten times as much as it stood for before; and if two Figures or Cyphers be annexed, it makes an hundred times as much as it stood for before, *&c.* as if you annex to the Figure 6 a Cypher, then it will be (60) sixty; so if two Cyphers are annexed, then it will be (600) six hundred, and if you do annex to it (4) four, then it will be (64) sixty four, and if you annex (78) seventy eight, it will be then (678) six hundred seventy eight, *&c.*

13. A negative or broken, fractional, decreasing Number, is that by which prefixing a Point or Prick toward the

left Hand, its Value has decreaſed from ſo many Units to ſo many tenth Parts of any Thing; and if a Point and (o) Cypher, or Digit, be prefixed, it will be then ſo many hundred Parts; and if a point and two Cyphers or Digits be prefixed, its Value is decreaſed to be ſo many thouſandth Parts; as if you would prefix before the Figure 3 a Point (.) or Prick thus (.3) it is then decreaſed from 3 Units or 3 Integers, to 3 tenth Parts of an Unit or an Integer; and if you prefix a Point and Cypher thus (.03) it is decreaſed from 3 Integers to 3 hundred Parts of an Integer; and by this Means 5 *l.* abſolute, by prefixing of a Point, will be decreaſed to .5 *l.* negative, which is 5 tenth Parts of a Pound, equal in Value to ten Shillings, and ſo by prefixing of more Cyphers or Digits, its Value is decreaſed in a decuple Proportion *ad infinitum.* As in the following Scheme, or rather Order of Numbers, we have placed (o) Cypher in its due Place in Order, as it is in the Beginning and Medium of Number; for going from (o) towards the left Hand, you deal with intire, abſolute, whole, increaſing Numbers.

Increaſing Numbers. Decreaſing Numbers.

25	629	876	543	21012	345	678	976	3
mm	mmm	mmm	mmm	CXUXC	mmm	mmm	mmm	m
mm	mmm	mmm	CX	|	XC	mmm	mmm	m
mm	mmm	CX		|		XC	mmm	m
mm	CX						XC	m
X								M

But going from (o) the Place of Units towards the right Hand, you meet with broken, negative, fractional and decreaſing Numbers. And hence it follows, that *Multiplication* increaſeth the Product in abſolute Numbers, but decreaſeth the Product in negative Numbers; alſo Diviſion decreaſeth the Quotient in whole Numbers, and increaſeth it in negative fractional Numbers.

14. An abſolute, intire, whole, increaſing Number, hath always a Point annexed towards the right Hand; and thereſore,

15. A negative, broken, decimal, decreaſing Number, hath always a Point prefix'd towards the left Hand. When we expreſs Integers or whole Numbers, as 5 *Pounds*, 5 *Feet*, 26 *Men*, we uſually annex a Point or Prick after the Number, thus,

	l.	*feet.*	*men.*	*inch.*
	5.	5.	26.	347.

But when we expreſs Decimals, or Numbers that are denied to be intire, or decreaſing Numbers, we do commonly prefix a Point or Prick before the ſaid Decimal or decreaſing

creasing Number, thus, (.3) that is, 3 Tenths, or 3 Primes (.03) that is 3 Hundredths, or 3 Seconds.

16. A whole or absolute Number is a Unit, or a composed Multitude of Units, and it is either a Prime or else a compound Number.

17. Prime Numbers amongst themselves, are those which have no Multitude of Units for a common Measure, as 8 and 7, or 10 and 13, because not any Multitude of Units can equally measure or divide them without a Remainder,

18. Compound Numbers amongst themselves, are those which have a Multitude of Units for a common Measure, as 9 and 12, because 4 measures them exactly, and abbreviates them to three and four.

19. A broken Number, commonly called a Fraction, is a Part or Parts of a whole Number, *viz.* A Part of an Integer, as $\frac{1}{3}$ one Third, is one third Part of an Unit.

20. A broken Number or Fraction consists of 2 Parts, *viz* the Numerator and Denominator.

21. The Numerator and Denominator of a Fraction are set one over the other, with a Line between them; and the Numerator is set above the Line, and expresseth the Parts therein contained.

22. The Denominator of a Fraction, is the inferior Number placed below the Line, and expresseth the Number of Parts, into which the Unit or Integer is divided; and let $\frac{3}{4}$ be the Fraction given, so shall 3 be the Numerator, and doth express or number the Multitude of Parts contained in this Fraction; for $\frac{3}{4}$ is a Fraction compounded of Fourths or Quarters, and the Figure 3 in numbering shews us, that in that Fraction there are 3 of the 4th Parts or Quarters, also in the same Fraction $\frac{3}{4}$ is the Denominator, and doth express the Quality of the Fraction, *viz.* that the Whole or Integer is divided into 4 equal Parts.

23. A broken Number is either proper or improper, *viz.* proper when the Numerator is less than the Denominator, for $\frac{3}{4}$ is a perfect proper Faction, but an improper Fraction hath its Numerator greater, or at least equal to the Denominator, thus $\frac{13}{8}$ is an improper Fraction, the Reason is given in the Definition.

24. A proper broken Number is either simple or compound, *viz.* simple when it hath one Denomination, and compound when it consisteth of divers Denominations; if

if $\frac{3}{4}$, $\frac{6}{12}$, $\frac{25}{100}$ were given, we ſay they are each of them ſingle or ſimple Fractions, becauſe they conſiſt but of one Numerator and one Denominator; but if $\frac{3}{4}$ of $\frac{6}{12}$ of $\frac{25}{100}$ of a Pound ſterling were given, we ſay that it is a compound broken Number or Fraction, becauſe the Expreſſion and Repreſentation conſiſteth of more Denominations than one, and ſuch by ſome are called Fractions for Fractions; they have always this Particle (of) between them.

25. When a ſingle broken Number or Fraction hath for his Denominator a Number conſiſting of a Unit in the firſt Place towards the left Hand, and nothing but Cyphers from the Unit towards the right Hand, it is then the more aptly and rightly called a Decimal Fraction; under this Head are all our decreaſing Numbers placed, and in our 13th Definition, called Negative; and by the Order there preſcribed, we order them to be Decimals, by ſigning a Prick or Point before them, or the Numerator, rejecting the Denominator; therefore according to our laſt Rule, $\frac{5}{10}$ $\frac{5}{100}$ $\frac{25}{1000}$, are then ſaid to be Decimals; and a Decimal Fraction may be expreſſed without its Denominator (as before) by prefixing a Point or Prick before the Numerator of the ſaid Fraction, and then ſhall the former Fractions $\frac{5}{10}$ and $\frac{25}{1000}$ ſtand thus, .5, and .025.

But oftentimes, as in the ſecond and fourth Fractions, $\frac{5}{100}$ and $\frac{25}{1000}$. a Prick or Point will not do without the Help of a Cypher or Cyphers prefixed before the ſignificant Figures of the Numerator, and therefore when the Numerator of a decimal Fraction conſiſteth not of ſo many Places as the Denominator hath Cyphers, fill up the void Places of the Numerator with prefixing Cyphers before the ſignificant Figures of the Numerator, and then ſign it for a Decimal, ſo ſhall $\frac{5}{100}$ be .05, and $\frac{25}{1000}$ will be .025, and $\frac{72}{10000}$ will be .0072. Now by this we may eaſily the diſcover the Denominator having the Numerator, for always the *Denominator* of any decimal Fraction conſiſts of ſo many Cyphers as the Numerator hath Places, with an Unit prefixed before the ſaid Cyphers, *viz.* under the Point or Prick.

26. A decimal Number or Fraction, is expreſſed by Primes, Seconds, Thirds, Fourths, &c. and is Number decreaſing. Here inſtead of natural and common Fractions,

ons, as $\frac{3}{4}$ of a Thing, we order the Thing or Integer into Primes, Seconds, Thirds, Fourths, Fifths, &c that our Expreſſion may be conſonant to our former Order.

27. In decimal Arithmetick we always imagine that all intire Units, Integers and Things are divided firſt into ten equal Parts, and theſe Parts ſo divided we call Primes; and Secondly, we divide alſo each of the former Primes into other ten equal Parts, and every one of theſe Diviſions we call Seconds; and Thirdly, we divide each of the ſaid Seconds into ten other equal Parts, and thoſe ſo divided we call Thirds; and ſo by decimating the former, and ſubdecimating theſe latter, we run on *ad infinitum*.

28. Let a Pound *ſterling*, *Troy-weight*, *Averdupois-weight*, *Liquid-meaſure*, *Dry meaſure*, *Long-meaſure*, *Time*, *Dozen*, or any other Thing or Integer be given to be decimally divided: In this Notion premiſed, we ought to let the firſt Diviſion be Primes, the next Diviſion Seconds, the next Thirds, &c. ſo one Pound *ſterling* being 20 Shillings, which divided into ten equal Parts, the Value of each Part will be 2 Shillings, therefore one Prime of a Pound *ſterling* will ſtand thus (.1) which is in Value 2 Shillings, 3 Primes will ſtand thus (.3) and that is in Value 6 Shillings. Again, a Prime, or .1 being divided into ten equal Parts, each of thoſe Parts will be one Second, and is thus expreſſed (.01) and its Value will be found 2*d.* Farthing and $\frac{6}{10}$ of a Farthing; and ſo will .05 ſignify one Shilling or five Seconds: And if .01 be divided into ten other equal Parts, each of thoſe Parts ſo divided will be Thirds, and will ſtand thus .001, and its Value will be found to be .96 of a Farthing, or $\frac{96}{100}$ of a Farthing, and .009 Thirds will be 2*d.* and .64 of a Farthing, or $\frac{64}{100}$ of a Farthing; ſo that .375*l.* will be found to repreſent 7*s.* 6*d.* for the 3 Primes are 6*s.* and the 7 Seconds are 1*s.* 4*d.* and $\frac{5}{10}$ of a Penny, and the 5 Thirds are 1 Penny $\frac{2}{10}$ of a Penny, both which added together make 7*s.* 6*d.*

29. If you put any Bulk or Body repreſenting an Integer, and it be decimally divided, then the Parts in the firſt Decimation are Primes, the next Seconds, and the next Decimation is Thirds, the next Fourths, &c. As let there be given a Bullet of Lead, or ſuch like, whoſe

Weight

Weight let it be 50lb *Troy*, this is called an Unit, Integer or Thing; then will the like Weight and Matter make 10 other, the which together will be equal to 50lb and will weigh each of them 5lb a-piece; take of the ſame Matter, and equal to 5lb make 10 more, then each of thoſe weigh 6 Ounces a-piece; alſo, if again you take 6 Ounces and thereof make 10 other ſmall Bullets, each of them will weigh 12 Penny-weight *Troy*; and thus have you made Primes, Seconds and Thirds, in reſpect of the Integer, containing 50lb *Troy-weight*; ſo that 5 Primes is equal to the half Maſs, and 2 Primes, and 5 Seconds is a quarter of the Maſs; and therefore one of the firſt Diviſion, two of the ſecond Diviſion, and five of the third Diviſion, will be equal in Weight to half a Quarter of the Maſs, and contains 6lb 3*oz*.

30. When a decimal Fraction followeth a whole Number, you are to ſeparate or part the Decimal from the whole Number by a Point or Prick; ſo if .75 follow the whole Number 32, ſet them thus, 32.75. You ſhall find that diverſe Authors have diverſe Ways in expreſſing mix'd Numbers, as thus, 32|75, or $32|\frac{75}{100}$, or $32|\ddot{75}$, but you will find that 32.75, thus placed and expreſſed, is the fitteſt for Calculation.

31. A mix'd Number hath two Parts, the whole and the broken; the whole is that which is compoſed of Integers, and the broken is a Fraction annexed thereunto. So the mix'd Number $36\frac{8}{12}$ being given, we ſay, that 36 is the whole Number, which is compoſed of Integers, and the $\frac{8}{12}$ is the broken Number annexed, which ſheweth that one of the former Integers (of that 36) being divided into 12 Parts, this $\frac{8}{12}$ doth expreſs 8 of thoſe 12 Parts more, belonging to the ſaid 36 Integers.

32. Denominative Numbers are of one, or of many, and thoſe are of diverſe Sorts and Kinds, *viz.* Singular, called Unit, as 8; and Plural a Multitude, as 2, 3, 4, 5; Single, of one Kind only called Digits, as 1, 2, 3, 4, 5, 6, 7, 8, 9. and Compounds of many, 10, 11, 12, *&c.* 102, 367, *&c.*

Proportional, as Single, Multiple, Double, Triple, Quadruple, *&c.* Denominate, as Pounds, Shillings, Pence; Undenominate, as 1, 2, 3, *&c.* Perfect, as 6, 28, 496, 8128, 130816, 2099128, *&c.* whoſe Parts are equal to the Numbers; imperfect unequal, and more than the Sum,

as 12, to 1, 2, 3, 4, 6; Imperfect, unequal, and less than the Sum, as 8 to 1, 2, 4: Numbers commensurable and incommensurable, as 12 and 9 are commensurable, because 3 measures them both; but 6 and 17 are incommensurable, because no one common Number or Measure can measure them; Linear, in form of a Line, as ..... ; Superficial, in form of a Superficies or Plane, as :::::: or ⁝ ⁝ *&c.* and Number cubical or solid, in form of a Cube: These two latter are otherwise called figurative Numbers. There are also other Numbers called tabular, as Sines, Tangents, Secants, *&c.* others that be called Logarithmetick, or borrowed Numbers, fitted to Proportion for Ease, and speedy Calculation of all manner of Questions.

CHAP. II.

Of the natural Divisions of Integers, and the several Denominations of the Parts

1. AND that we may advance methodically herein, we will begin with the main Pillars on which Arithmetick is founded, *viz.* the several Species of that Art: But first,

Of Money, Weights, &c.

2. The least Denomination or Fraction of Money used in *England* is a Farthing, from which is produced the following Table, called the Table of Coin, *&c.*

And therefore,

				l.	*s.*	*d.*	*qrs.*
1 Farthing	make	1 Farthing		1	20	12	4
2 Farthings		1 Penny		1	20	240	960
12 Pence		1 Shilling			1	12	48
20 Shillings		1 Pound				1	4

The first of these Tables, *viz.* that on the left Hand, is plain and easy to be understood, and therefore wants no Direction. In the second Table above the Line, you have 1*l.* 20*s.* 12*d.* 4*qrs.* whereby is meant, that 1 Pound is equal to 20 Shillings, and 1 Shilling is equal to 12 Pence, and 1 Penny equal to 4 Farthings; under that Line is 1*l.* 20*s.* 240*d.* 960 *qrs.* which signifies 1*l.* to contain 20 Shillings, or 240 Pence, or 960 Farthings; in the second Line below that is 1*s.* 12*d.* 48*qrs.* the first standing under the Denomination of Shillings, whereby is to be noted, that 1 Shilling is equal to 12 Pence or 48 Farthings; and likewise that below,

below, that one Penny is equal in Value to four Farthings. Understand the like Reason in all the following Tables of Weight, Measure, Time, Motion and Dozen. (See the Appendix to *Dilworth's* Arithmetick for the *Irish* Weights and Measures, *&c.*

Of Troy-weight:

3. The least Fraction or Denomination of Weight used in *England*, is a Grain of Wheat gathered out of the Middle of the Ear, and well dried; from whence are produced these following Tables of Weight, called *Troy-weight*.

32 Grains of Wheat	make	24 Artificial Grains
24 Artificial Grains	make	1 Penny-weight
20 Penny-weight	make	1 Ounce
12 Ounces	make	1 Pound Troy-weight

And therefore,

lb	oz.	pwt.	gr.
1	12	20	24
1	12	240	5760
	1	20	480
		1	24

Troy-weight serveth only to weigh Bread, Gold, Silver and Electuaries; it also regulateth and prescribeth a Form how to keep the Money of *England* at a certain Standard. But Bread in *Ireland* is now weighed by *Averdupois-weight*, and the Ounce is divided into eight Drams.

Of Apothecaries-weight.

4. The Apothecaries have their Weights deduced from *Troy-weight*, a Pound *Troy* being the greatest Integer, a Table of whose Division and Subdivision followeth, *viz.*

				And therefore, lb	oz.	dr.	scr.	gr.
1 Pound	make	12 Ounces		1	12	8	3	20
1 Ounce	make	8 Drams		1	12	96	288	5760
1 Dram	make	3 Scruples			1	8	24	480
1 Scruple	make	20 Grains				1	3	60
							1	20

5. Thus much concerning *Troy-weight* and its derivative Weights; besides which, there is another Kind of Weight used in *England*, known by the Name of *Averdupois-weight*, 1 Pound of which is equal to 14 Ounces 12 Penny-weight *Troy-weight*) and it serves to weigh all Kinds of Grocery-wares, and also Butter, Cheese, Flesh, Wax, Tallow, Rosin, Pitch, Lead, *&c.* the Table of Weight is as followeth.

A Table

A *Table of* Averdupois-weight.

4 Quarters of a Dram	make	1 Dram
16 Drams		1 Ounce
16 Ounces		1 Pound
28 Pounds		1 Quarter of a Hundred
4 Quarters		1 Hundred Wt. or 112 lb
20 Hundred		1 Tun

And therefore,

Tun	C.	*qrs.*	lb	*oz.*	*drams*	*qrs.*
1	20	4	28	16	16	4
1	20	80	2240	35840	573440	2293760
	1	4	112	1792	29672	114688
		1	28	448	7168	28672
			1	16	156	1024
				1	16	64
					1	4

Wool is weighed with this Weight, but only the Divisions are not the same.

*7 Pounds	make	1 Clove
2 Cloves		1 Stone
2 Stones		1 Todd
6 Todd 1 Stone		1 Wey
2 Weys		1 Sack
12 Sacks		1 Last

* In *Ireland*, 16 lb make a Stone of Wool.

And therefore,

last	*sack*	*wey*	*todd*	*stone*	*cloves*	lb
1	12	2	$6\frac{1}{2}$	2	2	7
1	12	24	156	312	624	4268
	1	2	13	26	52	364
		1	$6\frac{1}{2}$	13	26	182
			1	2	4	28
				1	2	14
					1	7

Note, That in some Counties the Wey is 256 lb *Averdupois*, as is the *Suffolk* Wey; but in *Essex* there is 336 lb in a Wey.

6. The least denominative Part of Liquid Measure is a Pint, which was formerly taken from *Troy-weight*, (1 Pound of Wheat *Troy-weight* making a Pint of Liquid Measure) but since, by a late Act of Parliament, to prevent Fraud in the Excise, the Pint Beer Measure is to contain 35 $\frac{1}{4}$ solid Inches, and the pint of Wine 28 $\frac{7}{8}$ the like Inches, &c.

A *Table*

A *Table of Liquid Meaſure*.

35 ¼ Cubical Inches	make	1 Pint Beer Meaſure
28 ⅞ Cubical Inches		1 Pint Wine Meaſure
2 Pints		1 Quart
2 Quarts		1 Pottle
†2 Pottles		1 Gallon
8 Gallons		1 Firkin of Ale, Soap or Herrings
9 Gallons		1 Firkin of Beer
10 Gallons and half		1 Firkin of Salmon or Eels
2 Firkins		1 Kilderkin
2 Kilderkins		1 Barrel
42 Gallons		1 Tearce of Wine
63 Gallons		1 Hogſhead
2 Hogſheads		1 Pipe or Butt
2 Pipes or Butts		1 Tun of Wine

† The *Iriſh* Gallon contains 217 $\frac{6}{10}$ cubic Inches, and 10 Gallons make a Firkin of Ale or Beer, 4 Firkins a Barrel, and 8 Barrels a Tun.

And therefore,

Tuns	*pipes*	*hhd.*	*gal.*	*pints*
1	2	2	63	8
1	2	4	252	2016
	1	2	126	1008
		1	63	504
			1	8

7. The leaſt denominative Part of Dry Meaſure is alſo a Pint, and this is likewiſe taken from *Troy-weight*.

A *Table of Dry Meaſure*.

1 Pound *Troy*	make	1 Pint
2 Pints		1 Quart
2 Quarts		1 Pottle
2 Pottles		1 Gallon
2 Gallons		1 Peck
4 Pecks		1 Buſhel
4 Buſhels		1 Comb, or *Iriſh* Barrel
2 Combs		1 Quarter
4 Quarters		1 Chaldron
5 Quarters		1 Wey
2 Weys		1 Laſt

And

And therefore,

last	*wey*	*qrs.*	*combs*	*bush.*	*pecks*	*gal.*	*pints*
1	2	5	2	4	4	2	8
1	2	10	20	80	320	640	5120
	1	5	10	40	160	320	2560
		1	2	8	32	64	512
			1	4	16	32	256
				1	4	8	64
					1	2	16
						1	8

8. The least denominative Part of Long-measure is a Barly-corn well dried, and taken out of the Middle of the Ear, whose Table of Parts followeth.

3 Barly-corns	make	1 Inch
12 Inches		1 Foot
3 Feet		1 Yard
3 Feet 9 Inches		1 Ell *English*
6 Feet		1 Fathom
5 Yards ½ in *England*. But 7 Yards of *Irish* Plantation Measure		1 Pole, Perch or Rod
40 Poles or Perches		1 Furlong
8 Furlongs		1 Mile

And therefore,

mile	*furl.*	*poles*	*yards*	*feet*	*inches*	*barly-corns*
1	8	40	5½	3	12	3
1	8	320	1760	5280	63360	190080
	1	4	220	660	7920	237620
		1	5½	16½	198	594
			2	3	36	108
				1	12	36
					1	3

And note, that the Yard, as also the Ell, is usually divided into Quarrers, and each Quarter into 4 Nails.

Note also, that a geometrical Pace is five Feet, and there are 1056 such Paces in an *Eng.* Mile, 1344 in an *Irish*.

9. The Parts of the superficial Measures of Land are such as are mentioned in the following Table, *viz.*

A *Table of Land-measure.*

40 Square Poles or Perches	make	1 Rood, or Quarter of an Acre
4 Roods		1 Acre

By

By the foregoing Table of *Long-measure* you are informed what a Pole or Perch is; and by this, that 40 square Perches is a Rood: now a square Perch is a Superficies very aptly resembled by a square Trencher, every Side thereof being a Perch in Length, 40 of them is a Rood, and 4 Roods an Acre; so that a Superficies that is 40 Perches long and 4 broad is an Acre of Land, the Acre containing in all 160 square Perches.

10. The least denominative Part of Time is one Minute, the greatest Integer being a Year, from whence is produced this

Table of Time.

1 Minute	make	1 Minute
60 Minutes		1 Hour
24 Hours		1 Day natural
7 Days		1 Week
4 Weeks		1 Month
13 Months, 1 Day, 6 Hours		1 Year

But the Year is usually divided into twelve unequal Calendar Months, whose Names, and the Number of Days they contain, are as follow, *viz.*

	Days		Days
January	31	*July*	31
February	28	*August*	31
March	31	*Septemb.*	30
April	30	*October*	31
May	31	*Novemb.*	30
June	30	*Decemb.*	31

So that the Year containeth 365 Days, and 6 Hours; but the 6 Hours are not reckon'd, but only every fourth Year, and then there is a Day added to the latter End of *February*, and then it containeth 29 Days; and that Year is called Leap-year, and containeth 366 Days.

And here note, that as the Hour is divided into 60 Minutes, so each Minute is sub-divided into 60 Seconds, and each Second into 60 Thirds, and each Third into 60 Fourths, *&c.*

The Tropical Year, by the exactest Observation of the most accurate Astronomers, is found to be 365 Days, 5 Hours, 49 Minutes, 4 Seconds and 21 Thirds.

CHAP. III.

Of the Species or Kinds of Arithmetick.

THere are several Species of this Art, and which may be termed either Natural, Artificial, Analytical, Algebraical, Lineal, or Instrumental; but what we are now to treat upon relates to the single Parts of Natural Arithmetick, so far as concerns Numeration; of which there are also four Kinds, *viz. Addition, Subtraction, Multiplication* and *Division.*

CHAP.

CHAP. IV.

Addition of Whole Numbers.

1. ADdition is the Reduction of two or more Numbers, of like Kind, together into one Sum or Total: Or, it is that by which diverse Numbers are added together, to the end that the Sum or total Value of them all may be discovered.

The first Number in every *Addition* is called the *Addible Number*; the other, the *Number* or *Numbers* added; and the *Number* invented by the *Addition* is called the *Aggregate* or *Sum*, containing the Value of the *Addition*.

The Collation of the Numbers, is the right placing the Numbers given respectively to each Denomination, and the Operation is the artificial adding of the Numbers given together, in order to the finding out of the Aggregate or Sum.

2. In *Addition* place the Numbers given respectively the one above the other, in such sort, that the like Degree, Place, or Denomination, may stand in the same Series, *viz.* Units under Units, Tens under Tens, Hundreds under Hundreds, *&c.* Pounds under Pounds, Shillings under Shillings, Pence under Pence, *&c.* Yards under Yards, Feet under Feet, *&c.*

3. Having thus placed the Numbers given (as before) and drawn under them, add them together, beginning with the lesser Denomination, *viz.* at the right Hand; and so on, subscribing the Sum under the Line respectively: As for Example.

Let there be given 3352, and 213, and 133, to be added together. I set the Units in each particular Number under each other, and so likewise the Tens under the Tens, *&c.* and draw a Line under them, as in the Margent; then I begin at the Place of Units and add them together upwards, saying, 3 and 3 are 6, and 2 makes 8, which I set under the Line, and under the same Figures added together; then I proceed to the next Place, being the Place of Tens, and add them in the same Manner as I did in the Place of Units, saying, 3 and 1 are 4 and 5 are 9, which likewise set under the Line respectively; then I go on to the Place of Hundreds, and add them up as I did the other, saying, 1 and 2 are 3 and 3 are 6, which is also set under the Line; and lastly, I go to the Place of Thousands, and because there are no other Figures to add to the 3, I set it under the Line in its respective

$$\begin{array}{r} 3352 \\ 213 \\ 133 \\ \hline 3698 \end{array}$$

respective Place, and so the Work is finished; and I find the Sum of the three given Numbers to be 3698.

4. But if the Sum of the Figures of any Series exceedeth ten, or any Number of Tens, subscribe under the same the Excess above the Tens, and for every ten carry one, to be added to the next Series towards the left Hand, and so go on till you have finished your Addition, always remembering, that how great soever the Sum of the Figures of the last Series is, it must all be set down under the Line respectively; so 3678 being given to be added to 2357, I set them down as is before directed, and as you see in the Margent, with a Line drawn under them, then I begin and add them together, saying, 7 and 8 are 15, which is 5 above 10, wherefore I set 5 under the Line, and carry 1 for the 10 to be added to the next Series, saying, 1 that I carried and 5 is 6 and 7 are 13, wherefore I set down 3, and carry 1 (for the Ten) to the next Series; then I say, 1 that I carry'd and 3 are 4 and 6 are 10, now, because it comes to just 10 and no more, I set 0 under the Line, and carry 1 for the 10 to the next, and say, 1 that I carried and 2 are 3 and 3 are 6, which I set down in its respective Place; thus the Addition is ended, and the total Sum of these Numbers is found to be 6035. Several Examples of this Kind follow.

$$\begin{array}{r} 3678 \\ 2357 \\ \hline 6035 \end{array}$$

$$\text{Numbers to be added}\left\{\begin{array}{r} 354867 \\ 573846 \\ 785946 \\ 347205 \end{array}\right.$$
$$\text{Sum } 2061864$$

$$\text{Numbers to be added}\left\{\begin{array}{r} 748647 \\ 465834 \\ 76483 \\ 648400 \end{array}\right.$$
$$\text{Sum } 1939364$$

$$\text{Numbers to be added}\left\{\begin{array}{r} 45346 \\ 38074 \\ 8437 \\ 923 \\ 76 \end{array}\right.$$
$$\text{Sum } 92856$$

5. If the Numbers given to be added are contained under divers Denominations, as of *Pounds*, *Shillings*, *Pence* and *Farthings*, or of *Tuns*, *Hundreds*, *Quarters*, *Pounds*, *&c.* then in this Case, having disposed of the Numbers of each Denomination under other of the like Kind, beginning at the least Denomination (minding how many of one Denomination do make an Integer of the next) and having added them up, for every Integer of the next greater Denomination that you find therein contained, bear

an Unit in mind to be added to the said next greater Denomination, expressing the Excess respectively under the Line; proceed in this manner until your Addition be finished; the following Example will make the Rule plain to the Learner. Thus these following Sums being given to be added, *viz.* 136*l.* 13*s.* 04*d.* 2*qrs.* and 79*l.* 07*s.* 10*d.* 3*qrs.* and 33*l.* 18*s.* 09*d.* 1*qr.* also 15*l.* 09*s.* 05*d.* 0*qrs.* The Numbers being disposed according to Order, will stand as in the Margent; then I begin at the Denomination of Farthings, and add them up, saying, 1 and 3 are 4 and 2 make 6. Now I consider that 6 Farthings are 1 Penny 2 Farthings; wherefore I set down the 2 Farthings in its Place under the Line, and keep 1 in mind to be added to the next Denomination of Pence; then I go on, saying, 1 that I carried and 5 are 6 and 9 are 15 and 10 are 25 and 4 are 29; now I consider that 29 Pence are 2 Shillings and 5 Pence, therefore I set down 5 Pence in Order under the Line, and keep 2 in mind for the 2 Shillings to be added to the Shillings; then I go on saying, 2 that I carried and 9 are 11 and 18 are 29 and 7 are 36 and 13 are 49; then I consider that 49 Shillings are 2 Pounds and 9 Shillings, wherefore I set the 9 Shillings under the Line, and carry 2 for the 2 Pounds to the next and last Denomination of Pounds, and proceed, saying, 2 that I carried and 5 makes 7 and 3 are 10 and 9 are 19 and 6 are 25; then I set down 5 and carry 2 for the Tens, and proceed, saying, 2 that I carry and 1 is 3 and 3 are 6 and 7 are 13 and 3 make 16, and I set down 6 and carry 1 for the 10, and go on, saying, 1 that I carried and 1 are 2, which I set in its place under the Line, and the Work is finished; and thus I find the Sum of the aforesaid Numbers to be 265*l.* 9*s.* 5*d.* 2 *qrs.* Here is another Example, in the Operation of which the Learner must have an Eye to the Table of *Troy weight*; the Numbers given are 38℔. 7*oz.* 13*pwt.* 18*gr.* and 50℔. 10*oz.* 10*pwt.* 12*gr.* and 42℔. 8*oz.* 5*pwt.* 16*gr.* and in order to the Addition thereof I place them as you see, and proceed to the Operation, saying, 16

l.	*s.*	*d.*	*qrs.*
136	13	04	2
79	07	10	3
33	18	09	1
15	09	05	0
265	09	05	2

and 12 are 28 and 18 are 46: now because 24 Grains make 1 Penny-weight, 46 Grains are 1 Penny-weight and 22 Grains, therefore I set down 22, and carry 1 for the Penny-weight, and 5 makes 6 and 10 are 16 and 13 are 29, which is 1 Ounce and 9 Penny-weight; I set down 9 in its place under the Line, and carry 1 to the Ounces, saying, 1 that I carry and 8 are 9 and 10 are 19, and 7 are 26, and because 26 Ounce, make 2 Pounds 2 Ounces, I set down 2 for the Ounces, and carry 2 to the Pounds, going on, 2 that I carry and 2 are 4 and 8 make 12, that is 2 and go 1; then 1 I carry and 4 are 5 and 5 are 10 and 3 are 13, which I set down as in the Margent, and the Work is finished; and I find the Sum of the said Numbers to amount to 132lb 2oz 9pwt. 22gr. The Way of proving these, or any Sum in this Rule, is shewed immediately after the ensuing Example.

lb	oz.	pwt.	gr.
38	07	13	18
50	10	10	12
42	08	05	16
132	02	09	22

Addition of English Money.

l.	s.	d.	q.
436	13	07	1
184	09	10	3
768	17	04	2
584	11	11	0
1974	12	09	2

l.	s.	d.	qrs
48	15	11	1
76	10	07	3
18	00	05	3
24	19	09	2
168	06	10	1

Addition of Troy-weight.

lb	oz.	pwt.	gr.
15	07	13	12
18	06	04	20
11	10	16	18
09	04	10	22
19	11	18	04
22	00	00	05
97	05	04	09

lb	oz.	pwt.	gr
145	09	12	18
726	08	14	10
389	07	06	13
83	10	16	20
130	00	10	12
74	07	15	00
1550	08	16	01

Addition of Apothecaries Weight.

℔	oz.	dr.	sc.	gr	℔	oz.	dr.	sc.	gr.
48	07	1	0	14	60	03	4	0	10
74	05	5	2	10	48	10	6	0	14
64	10	7	1	16	34	08	2	1	15
17	08	1	0	11	18	11	2	2	11
34	09	6	1	09	160	07	1	2	15
240	05	6	1	00	35	02	5	1	07
					358	07	7	0	12

Addition of Averdupois Weight.

Tuns	C.	qrs.	℔	℔	oun.	dr.
75	13	1	15	36	10	12
48	07	3	21	22	01	13
60	11	1	17	11	07	04
21	07	0	25	15	08	10
12	16	0	11	20	00	09
218	16	0	05	106	03	00

Addition of Liquid Measure.

Tuns	pipe	hhd.	gal.	Tuns	hdd.	gal.	pts
45	1	1	48	30	3	40	4
13	0	1	17	12	2	28	6
38	0	0	47	47	3	60	5
12	1	0	56	57	3	22	3
21	1	1	18	17	0	00	0
133	1	1	60	166	1	26	2

Addition of Dry Measure.

Chal.	qrs.	bush.	pec.	qrs.	bush.	pec.	gal.
48	3	7	3	17	3	1	1
13	1	4	0	50	1	3	0
54	0	6	2	14	5	3	1
16	3	6	1	40	2	0	1
40	1	0	1	30	0	3	0
173	3	0	3	152	5	3	1

Addition of Long Measure.

Yds.	qrs.	nails	Ells	qrs.	nails
35	3	3	56	1	3
14	1	2	13	3	2
74	2	3	48	2	1
38	0	1	50	0	2
30	1	0	74	2	0
15	0	0	17	1	0
208	1	1	260	1	0

Addition of Land Measure.

Acre	Rood	Perch	Acre	Rood	Perch
12	3	18	86	1	36
14	0	24	47	3	24
30	2	19	73	2	28
48	3	30	60	0	07
28	1	38	04	2	08
50	3	26	14	1	14
185	3	35	286	3	37

The Proof of Addition.

6. *Addition* is proved after this Manner: When you have found out the Sum of the Numbers given, then separate the uppermost Line from the rest, with a Stroke or Dash of the Pen, and then add them all up again as you did before, leaving out the uppermost Line; and having so done, add the new invented Sum to the uppermost Line you separated, and if the Sum of those two Lines be equal to the Sum first found out, then the Work is performed true, otherwise not. As for Example: Let us prove the first Example of *Addition of Money*, whose Sum we find to be 265*l*. 9*s*. 5*d*. 2*qrs*. and which we prove thus: Having separated the uppermost Number from the rest by a Line, as you see in the Margent, then I add the same together again, leaving out the said uppermost Line, and the Sum thereof I set under the first Sum, or true Sum, which doth amount to 128*l*. 16*s*. 1*d*. 0*qrs*. then again I add the new Sum to the uppermost Line that before was separated from the rest, and the Sum of these two is 265*l*. 09*s*. 05*d*. 2*qrs*. the same with the first Sum, and therefore I conclude that the Operation was rightly performed.

l.	s.	d.	qrs.
136	13	04	2
79	07	10	3
33	18	09	1
15	09	05	0
265	09	05	2
128	16	01	0
265	09	05	2

7. The main End of *Addition*, in Questions resolvable thereby, is to know the Sum of several Debts, Parcels, Integers, *&c*, Some Questions may be these that follow.

Quest. 1. There was an old Man whose Age was required; to which he replied, I have seven Sons, each having two Years between the Birth of each other, and in the 44th Year of my Age my eldest Son was born, which is now the Age of the youngest. I demand what was the old Man's Age?

Now to resolve this Question, first set down the Father's Age at the Birth of his first Child, which was 44; then the

the Difference between the oldeſt and the youngeſt, which is 12 Years, and then the Age of the youngeſt, which is 44; and then add them all together, and their Sum is 100, the compleat Age of their Father.

44
12
44
100

Queſt. 2. A Man lent his Friend, at ſeveral Times, theſe ſeveral Sums, *viz.* at one Time 63*l.* at another Time 50*l.* at another Time 48*l.* at another Time 156*l.* Now I deſire to know how much was lent him in all?

Set the Sums lent under one another, as you ſee in the Margent, and then add them together, and you will find their Sum to amount to 317*l.* which is the Total of all the ſeveral Sums lent, and ſo much is due to the Creditor.

63
50
48
156
317

Queſt. 3. There are two Numbers, the leaſt whereof is 40, and their Difference 14. I deſire to know what is the greater Number, and alſo what is the Sum of them both? Firſt ſet down the leaſt, *viz.* 40, and 14 the Difference, and add them together, and their Sum is 54 for the greateſt Number; then I ſet 40 (the leaſt) under 54 (the greateſt) and add them together, and their Sum is 94, equal to the greateſt and leaſt Numbers.

	40
	14
greateſt	54
leaſt	40
Sum	94

CHAP. V.

Of Subtraction *of Whole Numbers.*

SUbtraction, is taking of a leſſer Number out of a greater of a like Kind, whereby to find out a third Number, being or declaring the Inequality, Exceſs, or Difference between the Numbers given; or, *Subtraction* is that by which one Number is taken out of another Number given, to the end that the Reſidue or Remainder may be known, which Remainder is alſo called the Reſt, Remainder, or Difference of the Numbers given.

2. The Number out of which *Subtraction* is to be made muſt be greater, or at leaſt equal with the other Number given; the higher Number is called the *Major*, and the lower, *Minor*; and the Operation of *Subtraction* being finiſhed, the Reſt or Remainder is called the *Difference* of the Number given.

3. In *Subtraction*, place the Numbers given reſpectively, the one under the other, in ſuch Sort as like Degrees, Places, or Denominations may ſtand in the ſame Series, *viz.* Units under Units, Tens under Tens, Pounds under

Pounds, *&c.* Feet under Feet, and Parts under Parts, *&c.* This being done, draw a Line underneath, as in *Addition.*

4. Having placed the Numbers given as is before directed, and drawn a Line under them, ſubtract the lower Number (which in this Caſe muſt always be leſs than the uppermoſt) out of the higher Number, and ſubſcribe the Difference or Remainder reſpectively below the Line, and when the Work is finiſhed, the Number below the Line will give you the Remainder.

As for Example: Let 364521 be given to be ſubtracted from 795836, I ſet the leſſer under the greater, as in the Margent, and draw a Line under them; then beginning at the Right Hand, I ſay, 1 out of 6 and there remains 5, which I ſet in order under the Line; then I proceed to the next, ſaying, 2 from 3 reſts 1, which I note alſo under the Line; and thus I go on till I have finiſhed the Work, and then I find the Remainder or Difference to be 431315.

795836
364521
431315

5. But if it ſo happen (as commonly it doth) that the lowermoſt Number or Figure is greater than the uppermoſt: then in this Caſe add ten to the uppermoſt Number, and ſubtract the ſaid lowermoſt Number from their Sum, and the Remainder place under the Line, and when you go to the next Figure below pay an Unit, by adding it thereto, for the ten you borrowed before, and ſubtract that from the higher Number of Figures, and thus go on till your Subtraction be finiſhed. As for Example: Let 437503 be given, from whence it is required to ſubtract 153827, I diſpoſe of the Numbers as is before directed, and as you ſee in the Margent; then I begin, ſaying, 7 from 3 I cannot, but (adding 10 thereto) I ſay, 7 from 13 and there remains 6, which I ſet under the Line in Order; then I proceed to the next Figure, ſaying, 1 that I borrowed and 2 is 3 from 0 I cannot, but 3 from 10 and there remains 7, which I likewiſe ſet down as before; then 1 that I borrowed and 8 is 9 from 5 I cannot, but 9 from 15 and there remains 6; then 1 I borrowed and 3 is 4 from 7 and there remains 3; then 5 from 3 I cannot, but 5 from 13 and there remains 8; then 1 I borrowed and 1 are 2 from 4 and there reſt 2, and thus the Work is finiſh'd: After theſe Numbers are ſubtracted one from another, the Inequality, Remainder, Exceſs or Difference is found to be 283676. Examples for thy farther Experience may be theſe that follow.

347503
153827
283676

From	3469916	From	361577
Take	738642	Take	5864
Reſt	2731274	Reſt	355713

6. If

6. If the Sum or Number to be ſubtracted is of ſeveral Denominations, place the leſſer Sum below the greater, and in the ſame Rank and Order as is ſhewed in *Addition* of the ſame Numbers; then begin at the right Hand, and take the lower Number out of the uppermoſt, if it be leſſer; but if it be bigger than the uppermoſt, then borrow an Unit from the next greater Denomination, and turn it into the Parts of the leſs Denomination, and add thoſe Parts to the uppermoſt, noting the Remainder below the Line; then proceed and pay one to the next Denomination for that which you borrowed before, and proceed in this Order till the Work be finiſhed. An Example of this Rule followeth: Let 375*l.* 13*s.* 7*d.* 1*qr.* be given, from whence let it be required to ſubtract 57*l.* 16*s.* 3*d.* 2*qrs.* In order whereunto I place the Numbers as you ſee in the Margent; and thus I begin at the leaſt Denomination, ſaying, 2 from 1 I cannot, therefore I borrow one Penny from the next Denomination, and turn it into Farthings, which is 4, and adding 4 to 1, which is 5, I ſay, but 2 from 5 and there remains 3, which I put under the Line; then going on I ſay, 1 that I borrowed and 3 is 4 from 7 and there reſts 3; then going on I ſay, 16 from 13 I cannot, but borrowing 1 Pound, and turning it into 20 Shillings, I add it to 13, and that is (33) wherefore I ſay, 16 from 33 and there remains 17, which I ſet under the Line, and go on, ſaying, 1 that I borrowed and 7 is 8 from 5 I cannot, but 8 from 15 and there remains 7, and the 1 that I borrowed and 5 is 6 from 7 there reſts 1, and 0 from 3 reſts 3, and the Work is done: And I find the Remainder or Difference to be 317*l.* 17*s.* 3*d.* 3*qrs.*

l.	*s.*	*d.*	*qrs.*
375	13	07	1
57	16	03	2
317	17	03	3

Another Example, of *Troy-weight* may be this, I would ſubtract 17 lb 10 *oz.* 11 *pwt.* 20 *gr* from 24 lb 5 *oz.* 00 *pwt.* 08 *gr.* I place the Numbers according to the Rule, and begin ſaying, 20 from 8 I cannot, but I borrow 1 Penny-weight, which is 24 Grains, and add them to 8, and theſe are 32, wherefore I ſay 20 from 32 reſts 12; then 1 that I borrowed and 11 is 12 from 00 I cannot, but 12 from 20 (borrowing an Ounce, which is 20 Penny-weight) and there remains 8; then 1 that I borrowed and 10 is 11 from 5 I cannot, but 11 from 17 and there reſts 6; then 1 that I borrowed

lb	*oz.*	*pwt.*	*gr.*
24	05	00	08
17	10	11	20
06	06	08	12

and 7 is 8 from 4 I cannot, but 8 from 14 and there rests 6; then 1 that I borrowed and 1 is 2 from 2 and there rests nothing; so that I find the Remainder or Difference to be 6 ℔ 6 oz. 8 pwt. 12 gr.

7. It many times happeneth that you have many Sums or Numbers to be subtracted from one Number; as, suppose a Man should lend his Friend a certain Sum of Money, and his Friend hath paid him part of his Debt at several Times, then before you can conveniently know what is still owing, you are to add the several Numbers or Sums of Payment together, and subtract their Sum from the whole Debt, and the Remainder is the Sum due to the Creditor: As suppose *A* lendeth to *B* 564*l*. 16*s*. 10*d*. and *B* hath repaid him 79*l*. 16*s*. 8*d*. at one Time, and 163*l*. 18*s*. 11*d*. at another Time, and 241*l*. 15*s*. 8*d*. at another Time; and you would know how the Accompt standeth between them, or what is more due to *A*. In order whereunto I first set down the Sum which *A* lent, and draw a Line underneath it, then under that Line I set the several Sums of Payment, as you see in the Margent; and having brought the several Sums of Payment into one Total, by the 5th Rule of the 4th Chapter foregoing, I find their Sum amounteth to 485*l*. 11*s*. 3*d*. which I subtract from the Sum first lent by *A*, by the 6th Rule of this Chapter, and I find the Remainder to be 79*l*. 5*s*. 7*d*. and so much is still due to *A*.

	l.	*s.*	*d.*
Lent	564	16	10
Paid at several Payments.	79	16	08
	163	18	11
	241	15	08
Paid in all	485	11	03
Remains	79	05	07

When the Learner hath good Knowledge of what hath been already delivered in this and the foregoing Chapters, he will with Ease understand the Manner of working the following Examples.

Subtraction of Whole Numbers.

	l.	*s.*	*d.*	*l.*	*s.*	*d.*	*qrs.*
Borrowed	374	10	03	700	10	11	2
Paid	79	15	11	9	03	11	3
Remains	294	14	04	691	06	11	3

	l.	*s.*	*d.*	*l.*	*s.*	*d.*	*qrs.*
Borrowed	1000	00	00	711	03	00	0
Paid	19	00	06	11	13	00	1
Remains	980	19	06	699	09	11	3

Borrowed

	l.	s.	d.	qrs.
Borrowed	3500	00	00	0
Paid at several Payments.	170	10	00	0
	561	13	10	1
	590	03	04	3
	73	04	11	3
Paid in all	1195	12	02	3
Remains due	2304	07	09	1

Subtraction of Troy-weight.

	lb	oz.	pwt.	gr.
Bought	174	00	13	00
Sold	78	04	16	15
Remains	95	07	16	09

	lb	oz.	pwt.	gr.
Bought	470	10	13	00
Sold at several times.	60	00	00	00
	35	10	18	00
	16	07	09	08
	48	04	00	00
	61	11	19	23
	23	00	00	00
Sold in all	245	10	07	07
Remain unsold	225	00	05	17

Subtraction of Apothecaries Weight.

	lb	oz.	dr.	sc.	gr.	lb	oz.	dr.	sc.	gr.
Bought	12	04	3	0	00	20	00	1	0	07
Sold	8	05	1	1	15	10	00	1	2	12
Rem.	3	11	1	1	05	9	11	7	0	15

Subtraction of Averdupois-weight.

	C.	qrs.	lb	Tu.	C.	qrs.	lb	oz.	dr.
Bought	35	0	15	5	07	1	10	10	05
Sold	16	2	20	3	17	1	16	09	13
Remain	18	1	23	1	09	3	22	00	08

Subtraction of Liquid Measure.

	tu.	hhd.	gal.	tu.	hhd.	gal.	pints.
Bought	40	1	30	60	3	42	4
Sold	16	1	40	15	3	46	6
Remain	23	3	53	44	3	58	6

Subtraction of Dry Measure.

	chal.	qrs.	bush.	pec.	cha.	qrs.	bush.	pecks
Bought	100	0	0	0	73	2	3	2
Sold	54	1	4	3	46	2	3	3
Remain	45	2	3	1	26	3	7	3

Subtraction of Long Measure.

	yds.	qrs.	nails	yds.	qrs.	nails
Bought	160	0	0	344	0	1
Sold	64	1	2	177	1	3
Remain	95	2	2	166	2	2

Subtraction of Land Measure.

	acres	rood	perch.	acres	rood	perches
Bought	140	2	13	600	0	00
Sold	70	3	12	54	0	16
Remain	69	3	01	545	3	24

The Proof of Subtraction.

8. When your Subtraction is ended, if you desire to prove the Work, whether it be true or no, then add the Remainder to the *minor* Number, and if the Aggregate of these two be equal to the *major* Number, then is your Operation true, otherwise false: Thus let us prove the first Example of the fifth Rule of this Chapter, where, after Subtraction is ended, the Numbers stand as in the Margent, the Remainder or Difference being 283676: Now to prove the Work, I add the said Remainder 283676 to the *minor* Number 153827, by the fourth Rule of the foregoing Chapter, and I find the Sum or Aggregate to be 437503, equal to the *major* Number, or Number from whence the lesser is subtracted. See the Work in the Margent.

437503
153827
283676
437503

The Proof of another Example, may be of the first Example of the 6th Rule of this Chapter, where it is required, to subtract 57*l.* 16*s.* 3*d.* 2*qrs.* from 375*l.* 13*s* 7*d.* 1*qr.* and by the Rule I find the Remainder to be 317*l.* 17*s.* 3*d.* 3*qrs.* Now to prove it, I add the said Remainder 317*l.* 17*s.* 3*d.* 3*qrs.* to the *minor* Number 57*l.* 16*s.* 3*d.* 2*qrs.* and their Sum is 375*l.* 13*s.* 7*d.* 1*qr*, equal to the *major* Number, which proves the Work to be true; but if it had happened to be either more or less than the said *major* Number, then the Operation had been false.

l.	s.	d.	qrs.
375	13	07	1
57	16	03	2
317	17	03	3
375	13	07	1

9. The

9. The generel Effect of Subtraction, is, to find the Difference or Excess between two Numbers, and the Rest when a Payment is made in part of a greater Sum, the Date of Books printed, the Age of any Thing, by knowing the present Year, and the Year wherein they were made, created, or built, and such like.

The Questions appropriated to this Rule are such as follow.

Quest. 1. What Difference is there between one Thing of 125 Foot long, and another of 66 Foot long?

To resolve this Question, I first set down the *major* or greater Number 125, and under it the *minor* or lesser Number 66, as is directed in the third Rule of this Chapter, and according to the fourth Rule of the same, I subtract the *minor* from the *major*, and the Remainder, Excess, or Difference I find to be 59. See the Work in the Margent.

125
66
59

Quest. 2. A Gentleman hath owed a Merchant 365*l.* whereof he hath paid 278*l.* What more doth he owe?

To give an Answer to this Question, I first set down the *major* Number 365*l.* and under it I place 278 the *minor*, and subtract the one from the other, whereby I discover the Excess, Difference or Remainder to be 87; and so much is still due to the Creditor, as *per* Margent.

365
278
87

Quest. 3. An Obligation was written, a Book printed, a Child born, a Church built, or any other Thing made in the Year of our Lord 1572, and now we account the Year of our Lord 1751, the Question is, to know the Age of the said Things, that is, how many Years are passed since the said Things were made? I say, if you subtract the lesser Number 1572, from the greater 1751, the Remainder will be 179, and so many Years are passed since the making of the said Things; as by this Work in the Margent.

1751
1572
179

Quest. 4. There are three Towns lying in a straight Line, *viz. London, Huntingdon* and *York*, now the Distance between the farthest of these Towns, *viz. London* and *York*, is 151 Miles, and from *London* to *Huntingdon* is 49 Miles, I demand how far it is from *Huntingdon* to *York*?

To resolve this Question, subtract 49 the Distance between *London* and *Huntingdon*, from 151, the Distance between *London* and *York*, and the Remainder is 102, for the true Distance between *Huntingdon* and *York*. See the Work in the Margent.

151
49
102

CHAP. VI.

Multiplication of Whole Numbers.

1 MUltiplication is performed by two Numbers of like Kind, for the Production of a third, which shall have Reason to the one as the other hath to the Unit, and in Effect is a most brief and artificial *Compound Addition* of many equal Numbers of like Kind into one Sum. Or, *Multiplication* is that by which we multiply two or more Numbers, the one into the other, to the end that their Product may come forth, or be discovered.

Or, *Multiplication* is the increasing of any one Number by any other, so often as there are Units in that Number, by which the other is increased; or by having two Numbers given, to find a third which shall contain one of the Numbers as many Times as there are Units in the other.

2. *Multiplication* hath three Parts. First, the Multiplicand, or Number to be multiplied. Secondly, the Multiplier, or Number given, by which the Multiplicand is to be multiplied. And Thirdly, the Product, or Number produced by the other two, the one being multiplied by the other; as if 8 were given to be multiplied by 4, I say 4 times 8 is 32; here 8 is the Multiplicand, and 4 is the Multiplier, and 32 is the Product.

$$\begin{array}{r} 8 \\ \underline{4} \\ 32 \end{array}$$

3. *Multiplication* is either *Single*, by one Figure; or *Compound*, that consists of many.

Single Multiplication is said to consist of one Figure, because the Multiplicand and Multiplier consist each of 'em of a Digit, and no more; so that the greatest Product that can arise by *Single Multiplication* is 81, being the Square of 9; and *Compound Multiplication* is said to consist of many Figures, because the Multiplicand or Multiplier consists of more Places than one; as if I were to multiply 436 by 6: It is called *Compound*, because the Multiplicand 436 is of more Places than one, *viz.* 3 Places.

4. The Learner ought to have all the Varieties of *Single Multiplication* by Heart, before he can well proceed any farther into this Art, it being of most excellent Use, and none of the following Rules in *Arithmetick* but what have a principal Dependance thereupon.

Multiplication TABLE.

1	2	3	4	5	6	7	8	9
2	4	6	8	10	12	14	16	18
3	6	9	12	15	18	21	24	27
4	8	12	16	20	24	28	32	36
5	10	15	20	25	30	35	40	45
6	12	18	24	30	36	42	48	54
7	14	21	28	35	42	49	56	63
8	16	24	32	40	48	56	64	72
9	18	27	36	45	54	63	72	81

The Uſe of the precedent Table is this: In the uppermoſt Line or Column you have expreſſed all the Digits from 1 to 9, and likewiſe beginning at 1 and going downwards in the ſide Column, you have the ſame; ſo that if you would know the Product of any two ſingle Numbers multiplied by one another, look for one of them (which you pleaſe) in the uppermoſt Column, and for the other in the ſide Column, and running your Eye from each Figure along the reſpective Columns in the common Angle (or Place) where theſe two Columns meet, there is the Product required. As for Example, I would know how much is 8 times 7; firſt, I look for 8 in the uppermoſt Column, and 7 in the ſide Column; then do I caſt my Eye from 8 along the Column downwards from the ſame, and likewiſe from 7 in the ſide Column, I caſt my Eye from thence toward the right Hand, and find it to meet with the firſt Column at 56, ſo that I conclude 56 to be the Product required, *&c.*

5. In *Compound Multiplication*, if the Multiplicand conſiſts of many Places, and the Multiplier of but one Figure, firſt ſet down the Multiplicand, and under it place the Multiplier in the place of Units, and draw a Line underneath them; begin then and multiply the Multiplier into every particular Figure of the Multiplicand, beginning at the place of Units, and ſo proceed towards the left Hand, ſetting each particular Product under the Line, in Order as you proceed; but if any of the Products exceed 10, or any Number of Tens, ſet down the Exceſs, and for every 10 carry an Unit to be added to the next Product, always remembring to ſet down the total Product of the laſt Figure; which Work being finiſhed, the Sum or Number placed under the Line ſhall be the true and total Product required,

required. As for Example, I would multiply 478 by 6; first set down 478, and underneath it 6, in the place of Units, and draw a Line underneath them, as in the Margent, then I begin, saying 6 times 8 is 48, which is 8 above four Tens, therefore I set down 8 (the Excess) and bear 4 in mind for the 4 Tens; then I proceed, saying, 6 times 7 is 42, and 4 that I carried is 46, I then set down 6 and carry 4, and go on, saying, 6 times 4 is 24, and 4 that I carried is 28, and because it is the last Figure I set it all down, and so the Work is finished, and the Product is found to be 2868, as was required.

$$\begin{array}{r} 478 \\ 6 \\ \hline 2868 \end{array}$$

6. When in *Compound Multiplication* the Multiplier consisteth of divers Places, then begin with the Figure in the place of Units in the Multiplier, and multiply it into all the Figures in the Multiplicand, placing the Product below the Line, as was directed in the last Example; then begin with the Figure of the second Place of the Multiplier, *viz.* the place of Tens, and multiply it likewise into the whole Multiplicand (as you did the first Figure) placing its Product under the Product of the first Figure; do in the same manner by the third, fourth and fifth, *&c.* until you have multiplied all the Figures of the Multiplier particularly into the whole Multiplicand, still placing the Product of each particular Figure under the Product of its precedent Figure; herein observing the following Caution.

A Caution. In the placing of the Product of each particular Figure of the Multiplier, you are not to follow the 2d Rule of the 4th Chapter, *viz.* to place Units under Units, and Tens under Tens, *&c.* but to place the Figure or Cypher in the place of Units of the second Line under the second Figure or place of Tens in the Line above it, and the Figure or Cypher in the place of Units in the third Line under the place of Tens in the second Line, *&c.* observing this Order till you have finished the Work, still placing the first Figure of every Line or Product under the second Figure or Place of Tens in that which was above it, and having so done, draw a Line under all these particular Products and add them together; so shall the Sum of all these Products be the total Product required.

As if it were required to multiply 764 by 27, I set 'em down the one under the other, with a Line drawn underneath them, then I begin, saying, 7 times 4 is 28, then I set down 8 and carry 2; then I say, 7 times 6 is 42, and 2 that I carried is 44, that is 4 and go 4; then 7 times 7 is 49, and 4 that I carry is 53, which I set down because I have not anoth-

$$\begin{array}{r} 764 \\ 27 \\ \hline 5348 \\ 1528 \\ \hline 20628 \end{array}$$

another Figure to multiply; thus I have done with the 7; then I begin with the 2, ſaying, 2 times 4 is 8, which I ſet down under (4) the ſecond Figure or place of Tens in the Line above it, as you may ſee in the Margent; then I proceed, ſaying, 2 times 6 is 12, that is 2 and carry 1, then 2 times 7 is 14, and 1 that I carry is 15, which I ſet down, becauſe it is the Product of the laſt Figure, ſo that the Product of 764 by 7 is 5348, and by 2 is 1528, which being placed the one under the other, as before directed, as you ſee in the Margent, and a Line drawn under them, and they added together reſpectively, make 20628, the true Product required, being equal to 27 times 764.

Another Example may be this: Let it be required to multiply 5486 by 465, I diſpoſe of the Multiplicand and Multiplier according to the Rule, and begin multiplying the firſt Figure of the Multiplier, which is (5) into the whole Multiplicand, and find the Product is 27430; then I proceed, and multiply the ſecond Figure (6) of the Multiplier into the Multiplicand, and find the Product to amount to 32916, which is ſubſcribed under the other Product reſpectively; then do I multiply the third and laſt Figure (4) of the Multiplier into the Multiplicand, and the Product is 21944, which is likewiſe placed under the ſecond Line reſpectively; then I draw a Line under the ſaid Products, being placed the one under the other (according to Rule) and add them together, and the Sum is 2550990, the true Product ſought, being equal to 5486 times 465, or 465 times 5486.

```
  5486
   465
-------
  27430
 32916
21944
-------
2550990
-------
```

More Examples in this Rule are theſe following.

```
   430865
     4739
 ---------
  3877785
 1292595
3016055
1723460
 ---------
2041869235
```

```
     6400758
       37496
   ----------
    38404548
   57606822
  25603032
 44805306
19202274
   ----------
240002821968
```

Compendium in Multiplication.

7. Altho' the former Rules are ſufficient for all Caſes in *Multiplication*, yet becauſe in the Work of *Multiplication* many times great Labour may be ſaved, I ſhall acquaint the

the Learner with ſome Compendiums in order thereto, *viz.* if the Multiplicand or Multiplier, or both of them, end with Cyphers, then in your multiplying you may neglect the Cyphers, and multiply only the ſignificant Figures, and to the Product of thoſe ſignificant Figures add ſo many Cyphers as the Numbers given to be multiplied did end with; that is, annex them on the right Hand of the ſaid Product, ſo ſhall that give you the true Product required. As if I were to multiply 32000 by 4300, I ſet them down in order to be multiplied, as you ſee in the Margent, but neglecting the Cyphers in both Numbers, I only multiply 32 by 43, and the Product I find to be 1376, to which I annex the 5 Cyphers in the Multiplicand and Multiplier, and then it makes 137600000 for the true Product of 32000 by 4300.

Si numeris propoſitis unus vel uterque adjunctos habeat ad dextram circulos, omiſſis circulis fiat ipſorum numerorum multiplicatio, & facto demum tot inſuper integrorum loci accenſeantur quot ſunt omiſſi circuli in utraque factore. Clavis Mat. *c.* 4. 3.

```
    32000
     4300
    -----
     96
    128
---------
137600000
```

8. If in the Multiplier, Cyphers are placed between ſignificant Figures, then multiply only by the ſignificant Figures neglecting the Cyphers; but here ſpecial Notice is to be taken of the true placing of the firſt Figure after the Neglect of ſuch Cypher or Cyphers, and therefore you muſt obſerve in what place of the Multiplier the Figure you multiply by ſtandeth, and ſet the firſt Figure of that Product under the ſame Place of the Product of the firſt Figure of your Multiplier: As for Example, let it be required to multiply 371568 by 40007; firſt I multiply the Multiplicand by 7, and the Product is 2600976; then, neglecting the Cyphers, I multiply by 4, and that Product is 1486272; now I conſider that 4 is the fifth Figure in the Multiplier, therefore I place 2 (the firſt Figure of the Product by 4) under the fifth place of the firſt product by 7, and the reſt in Order, and having added them together, the total Product is found to be 14865320976. Other Examples in this Rule are theſe following.

Si intermedio multiplicantis loco circulus fuerit, ille negligitur. Alſted. *c.* 6. *de Arith.*

```
     371568
      40007
-----------
    2600976
1486272....
-----------
14865320976
```

```
      327586
        6030
  ----------
     9827580
   1965516
  ----------
  1975343580
```

```
       7864371
         20604
  ------------
      31457484
    47186226
   15728742
  ------------
  162037500084
```

9. If you are to multiply any Number by an Unit with Cyphers, as by 10, 100, 1000, *&c.* then annex so many Cyphers before the Multiplicand, and that Number when the Cyphers are annexed is the Product required. As if you would multiply 428 by 100, annex two Cyphers to 428, and it is 42800. If it were required to multiply 102 by 10000, annex 4 Cyphers, and it gives 1020000 for the Product required.

The Proof of Multiplication.

10. *Multiplication* is proved by *Division*, and to speak Truth, all other Ways are false (according to *Frisius*) and therefore it will be necessary in the first place to learn *Division*, and by that to prove *Multiplication*. There are some other Ways used indeed, but on a strict *Examen*, there is not one in a thousand of their Products right; therefore we omit them.

11. The general Effect of *Multiplication* is contained in the Definition of the same, which is to find out a third Number, so often containing one of the two given Numbers as the other containeth Units.

The second Effect is, by having the Length and Breadth of any Thing (as a Parallelogram or long Plain) to find the superficial Content of the same, and by having the superficial Content of the Base, and the Length, to find out the Solidity of any Parallelopipedon, Cylinder, or other solid Figure.

The third Effect is, by the Contents, Price, Value, buying, selling, Expence, Wages, Exchange, Simple Interest, Gain or Loss of any one Thing, be it Money, Merchandize, *&c.* to find out the Value, Price, Expence, buying, selling, Exchange, or Interest, of any Number of Things of the like Name, Nature and Kind.

The fourth Effect is not much unlike the other, by the Contents, Value or Price of any one Part of any Thing denominated, to find the Contents, Value or Price of the whole Thing, all the Parts into which the Whole is divided, multiplying the Price of one of those Parts.

The fifth Effect is, to aid, to compound and to make other Rules, as chiefly, the *Rule of Proportion*, called the *Golden Rule*, or *Rule of Three*; also by it Things of one Denomination are reduced to another.

If

If you multiply any Number of Integers, or the Price of the Integer, the Product will discover the Price of the Quantity, or Number of Integers given.

In a rectangular Solid, if you multiply the Breadth of the Base by the Depth, and that Product by the Length, the last Product will discover the Solidity or Content of the same Solid.

Some Questions proper to this Rule, may be these following.

Quest. 1. What is the Content of a square Piece of Ground, whose Length is 28 Perches and Breadth 13?

Answer, 364 square Perches; for multiplying 28 the Length, by 13 the Breadth, the Product is so much.

Quest 2. There is a square Battle, whose Flank is 47 Men, and the Files 19 deep, what Number of Men doth that Battle contain? *Facit* 893; for multiplying 47 by 19 the Product is 893.

Quest. 3. If any one Thing cost 4 Shillings, what shall 9 Things cost? *Answ.* 36 Shillings; for multiplying 4 by 9 the Product is 36.

Quest 4. If a Piece of Money or Merchandize be worth or cost 17 Shillings, what shall 19 such Pieces of Money or Merchandize cost? *Facit* 323 Shillings, which is equal to 16*l.* 3*s.*

Quest. 5. If a Soldier or Servant get or spend 14 *s. per* Month, what is the Wages or Charges of 49 Soldiers or Servants for the same Time? Multiply 49 by 14, the Product is 686*s.* or 34*l.* 6*s.* for the Answer.

Quest. 6. If in a Day there are 24 Hours, how many Hours are there in a Year, accounting 365 Days to constitute the Year? *Facit* 8760 Hours, to which if you add the 6 Hours over and above 365 Days, as there is in a Year, then it will be 8766 Hours; now if you multiply this 8766 by 60, the Number of Minutes in an Hour, it will produce 525960, the Number of Minutes in a Year.

CHAP. VII.

Division of Whole Numbers.

1. DIvision is the separating or parting of any Number or Quantity given, into any Part assigned; or to find how often one Number is contained in another; or from any two Numbers given, to find a third that shall consist of so many Units, as the one of those two Numbers given is comprehended or contained in the other.

2. *Division* hath three Parts of Numbers remarkable, *viz. first,* the Dividend; *2dly,* the Divisor, *3dly,* the Quotient

tient. The Dividend is the Number given to be parted or divided. The Divisor is the Number given by which the Dividend is divided, or it is the Number which sheweth how many Parts the Dividend is to be divided into, and the Quotient is the Number produced by the Division of the two given Numbers the one by the other.

So 12 being given to be divided by 3, or into three equal Parts, the Quotient will be 4; for 3 is contained in 12 four times, where 12 is the Dividend, and 3 is the Divisor, and 4 is the Quotient.

3. In *Division*, set down your Dividend, and draw a crooked Line at each End of it, and before the Line at the left Hand place the Divisor, and behind that on the right Hand place the Figures of the Quotient, as in the Margent, where it is required to divide 12 by 3; first, I set down 12 the Dividend, and on each Side of it I do draw a crooked Line, and before that on the left Hand do I place 3 the Divisor, then do I seek how often 3 is contained in 12, and because I find it four times, I put 4 behind the crooked Line, on the right Hand of the Dividend, denoting the Quotient.

3) 12 (4

4. But if, when the Divisor is a single Figure, the Dividend consisteth of two or more Places, then having placed them for the Work (as before directed) put a Point under the first Figure of the left Hand of the Dividend, provided it be bigger than (or equal to) the Divisor: but if it be lesser than the Divisor, then put a Point under the second Figure from the left Hand of the Dividend, which Figures, as far as the Point goeth from the left Hand, are to be reckon'd by themselves as if they had no Dependance upon the other part of the Dividend, and for Distinction sake may be called the Dividual; then ask how often the Divisor is contained in the Dividual, placing the Answer in the Quotient, then multiply the Divisor by the Figure that you placed in the Quotient, and set the Product thereof under your Dividual, then draw a Line under the Product, and subtract the said Product from the Dividual, placing the Remainder under the said Line; then put a Point under the next Figure in the Dividend, on the right Hand of that to which you put the Point before, and draw it down, placing it on the right Hand of the Remainder which you found by *Subtraction*, which Remainder, with the said Figure annexed before it, shall be a new Dividual; then seek again how often the Divisor is contained in this new Dividual, and put the Answer in the Quotient, on the right Hand of the Figure which you put there before; then multiply the Divisor by the last Figure that you put in the Quotient, and subscribe the

the Product under the Dividual and make Subtraction, and to the Remainder draw down the next Figure from the grand Dividend (having first put a Point under it) and put it on the right Hand of the Remainder for a new Dividual, as before; and proceed thus till the Work is finished.

Observing this general Rule in all Kinds of *Division*; first, to seek how often the Divisor is contained in the Dividual, then (having put the Answer in the Quotient) multiply the Divisor thereby, and subtract the Product from the Dividual: An Example or two will make the Rule plain. Let it be required to divide 2184 by 6. I dispose of the Numbers given as is before directed, and as you see in the Margent; in order to the Work, then

```
6) 2184 (3
```

because 6 the Divisor is more than 2 the first Figure of the Dividend, I put a Point under 1 the second Figure, which makes 21 for the Dividual; then do I ask how often 6 the Divisor is contained in 21, and because I cannot have it more than 3 times, I put 3 in the Quotient, and thereby do I multiply the Divisor (6) and the Product is 18, which I set in order under the Dividual, and subtract it therefrom, and the Remainder (3) I place in order under the Line, as you see in the Margent.

```
6) 2184 (3
    .
   18
   --
    3
```

Then do I make a Point under the next Figure of the Dividend, being 8, and draw it down, placing it before the Remainder 3, so have I 38 for a new Dividual; then do I seek how often 6 is contained in 38, and because I can't have it more than 6 times, I put 6 in the Quotient, and thereby do I multiply the Divisor 6, and the Product (36) I put under the Dividual (38) and subtract it therefrom, and the Remainder (2) I put under the Line, as you see in the Margent.

```
6) 2184 (36
    ..
   18
   ---
    38
    36
   ---
```

Then do I put a Point under the next (and last) Figure of the Dividend (being 4) and draw it down to the Remainder 2, and putting it on the right Hand thereof, it maketh 24 for a new Dividual; then I ask how often 6 is contained in 24, and the Answer is 4, which I put in the Quotient, and multiply the Divisor (6) thereby, and the Product (24) I put under the Dividual (24) and subtract it therefrom, and the Remainder is (0); and thus the Work is finished, and I find the Quotient to be 364, that is, 6 is contained in 2184 just 364 times, or 2184 being divided into 6 equal Parts, 364 is one of those Parts.

```
6) 2184 (364
    ...
   18
   ---
    38
    36
   ---
     24
     24
    ---
     (0)
```

Again,

Again, If it were required to divide 2646 by 7, or into 7 equal Parts, the Quotient will be found to be 378, as by the following Operation appeareth.

```
7) 2646 (378
   ...
   21
   --
    54
    49
    --
     56
     56
     --
     00
```

So if it be required to divide 946 by 8, the Quotient will be found to be 118, and 2 remaining after Division is ended. The Work followeth:

```
8) 946 (118
   ..
   8
   --
   14
    8
   --
    66
    64
    --
    (2
```

Many times the Dividend cannot exactly be divided by the Divisor, but something will remain, as in the last Example, where 946 was given to be divided by 8, the Quotient was 118, and there remained 2 after the Division was ended: Now what is to be done in this Case with the Remainder, the Learner shall be taught when we come to treat of the reducing (or Reduction) of Fractions.

And here note, That if, after your Division is ended, any Thing do remain, it must be lesser than your Divisor, for otherwise your Work is not rightly performed.

Other Examples are such as follow.

```
8)73464(9183          9)13758(1528
  ....                  ....
  72                    9
  --                    --
   14                   47
    8                   45
   --                   --
    66                   25
    64                   18
    --                   --
     24                   78
     24                   72
     --                   --
     (0)                  (6)
```

But

5. But if the Divisor consisteth of more Places than one, then chuse so many Figures from the left Side of the Dividend for a Dividual as there are Figures in the Divisor, and put a Point under the farthest Figure of that Dividual to the right Hand, and seek how often the first Figure on the left Side of the Divisor is contained in the first Figure on the left Side of the Dividual, and place the Answer in the Quotient, and thereby multiply your Divisor, placing your Product under your Dividual, and subtract it therefrom, placing the Remainder below the Line; then put a Point under the next Figure in the Dividend, and draw it down to the said Remainder, and annex it on the right Side thereof, which makes a new Dividual, and proceed as before, till the Work is finished.

And if it so happen, that after you have chosen your first Dividual, (as is before directed) you find it to be lesser than the Divisor, then put a Point under the Figure more near to the right Hand, and seek how often the first Figure on the left Side of the Divisor is contained in the two first Figures on the left Side of the Dividual, and place the Answer in the Quotient, by which multiply the Divisor, and place the Product thereof in order, under the Dividual, and subtract it therefrom, and proceed as before.

Always remembering that in all Cases of *Division*, if after you have multiplied your Divisor by the Figure last placed in the Quotient, the Product be greater than the Dividual, then you must cancel that Figure in the Quotient, and instead thereof put a Figure lesser by an Unit (or one) and multiply the Divisor thereby, and if still the Product be greater than the Dividual, make the Figure in the Quotient yet lesser by an Unit, and thus do until your Product be lesser than the Dividual, or at the most equal thereto, and then make Subtraction, &c.

So if you would divide 9464 by 24, the Quotient will be found to be 394; I first put down the given Number, as is before directed in the 3d Rule. Now because my Divisor consisteth of two Figures, I therefore put a Point under the second Figure from the left Hand of my Dividend, which here is 4, wherefore I seek how often 2 the first Figure (on the left Side of the Divisor) is contained in 9, the like first in the Dividual, the Answer is 4, which I put in the Quotient, and thereby multiply all the Divisor, and find the Product to be 96, which is greater than the Dividual 94, wherefore I cancel the 4 in the Quotient, and instead thereof I put 3 (an Unit lesser) and by it multiply the Divisor 24, and the Product

```
24)9464(39
     ...
    72
    226
    216
     10
```

Product is 72, which I subtract from 94 the Dividual, and the Remainder is 22; then do I make a Point under the next Figure 6 in the Dividend, and draw it down and place it on the right Side of the Remainder 22, and it makes 226 for a new Dividual; now because the Dividual 226 consisteth of a Figure more than the Divisor, therefore I seek how often 2 (the first Figure of the Divisor) is contained in 22, the two first Figures of the Dividual, and I say 9 times, wherefore I put 9 in the Quotient, and thereby multiply the Divisor 24, the Product (216) I place under the Dividual 226, and subtract it, and there remaineth 10.

```
24)9464(39
    ...
   72
   226
   216
    10
```

Then I go on and make a Point under the next and last Figure (4) in the Dividend, and draw it down to the Remainder 10, and it makes 104 for a new Dividual, which is also a Figure more than the Divisor, and therefore I seek how often 2 is contained in 10, I answer 5 times; but multiplying my Divisor by 5, the Product is 120, which is greater than the Dividual, and therefore I make it but 4, and by it multiply the Divisor, and the Product is 96, which being placed under, and subtracted from the Dividual, there remaineth 8; and thus the whole Work of this Division is ended, and I find that 9464 being divided by 24, or into 24 equal Parts, is found to be 394, as was said before, and the Remainder is 8, as you see in the Work following.

```
24)9464(394
    ...
   72
   226
   216
    104
     96
    (8)
```

Another Example may be this: Let there be required the Quotient of 1183653 divided by 385: First I dispose of the Numbers in order to their dividing, and because 118, the three first Figures of the Dividend, is lesser than the Divisor 385, I therefore make a Point under the fourth Figure, which is 3, and seek how often 3 (the first Figure of the Divisor) is contained in 11; the Answer is 3, which I put in the Quotient, and thereby multiply the Divisor 385, and the Product is 1155, which I subtract from the Dividual 1183, and there remains 28: Then, as before, I draw down the next Figure, which is

```
385)1183653(3
       .
    1155
      28
```

is 6, and place it before the Remainder 28, so have I 286 for a new Dividual, and because it hath no more Figures than the Divisor, I seek how often 3 (the first Figure of the Divisor) is contained in 2 (the first Figure of the Dividual) and the Answer is o; for a greater Number cannot be contained in a lesser; wherefore I put o in the Quotient, and thereby, according to the fifth Rule, I should multiply the Divisor, but if I do the Product will be o, and o subtracted from the Dividual 286, the Remainder is the same; wherefore I draw down the next Figure (5) from the Dividend, and put it before the said Remainder 286, so have I 2865 for a new Dividual; and because it consisteth of four Places, *viz.* a Place more than the Divisor, I seek how often 3, the first Figure of the Divisor, is contained in 28, the two first of the Dividual, and I say there is 9 times 3 in 28; but multiplying my whole Divisor (385) thereby, I find the Product to be 3465, which is greater than the Dividual 2865; wherefore I chuse 8, which is lesser by an Unit than 9, and thereby I multiply my Divisor 385, and the Product is 3080, which still is greater than the said Dividual: wherefore I chuse another Number yet an Unit lesser, *viz.* 7, and having multiplied my Divisor thereby the Product is 2695, which is lesser than the Dividual 2865, wherefore I put 7 in the Quotient, and subtract 2695 from the Dividual 2865, and there remains 170; then I draw down the last Figure (3) in the Dividend, and place it before the said Remainder 170, and it makes 1703 for a new Dividual; then, for the Reason abovesaid, I seek how often 3 is contained in 17, the Answer is 5, but multiplying the Divisor thereby, the Product is 1925, greater than the Dividual, wherefore I say it will bear 4 (an Unit lesser) and by it I multiply the Divisor 385 and the Product is 1540, which is lesser than the Dividual, and therefore I put 4 in the Quotient, and subtract the said Product from the Dividual, and there remains 163; and thus the Work is finished, and I find that 1183653 being divided by 385, or into 385, or into 385 equal Shares or Parts, the Quotient, or one of those Parts, is 3074, and besides there is 163 remaining.

```
385)1183653)30
     .
   1155
    286
```

```
385)1183653(507
     ...
   1155
    2865
    2695
     170
```

```
385)1183653(3074
     ....
   1155
    2865
    2695
     1703
     1540
     (163)
```

And

And thus the Learner being well versed in the Method of the foregoing Examples, he may be sufficiently qualified for the dividing of any greater Sum or Number into as many Parts as he pleaseth; that is, he may understand the Method of dividing by a Divisor which consisteth of 4, or 5, or 6, or any greater Number of Places, the Method being the same with the foregoing Examples in every respect.

Other Examples in Division.

27986)835684790(29860

55972

275964

251874

240907

223888

170199

167916

Remain (22830)

196374(473986018(2413

392748

812380

785496

268841

196374

724678

589122

Remain (135556)

So if you divide 47386473 by 58736, you will find the Quotient to be 806, and 45257 will remain after the Work is ended.

In like manner: if you would divide 3846739204 by 483064, the Quotient will be 7963, and the Remainder after Division will be 100572.

Compendiums in Division.

1. IF any given Number be to be divided by another Number that hath Cyphers annexed on the right Side thereof, (omitting the Cyphers) you may cut off so many Figures from the right Hand of the Dividend, as there are Cyphers before the Divisor, and let the remaining Numbers in the Dividend be divided by the remaining Num-

bers of the Divisor, observing this Caution, That if after your Division is ended any thing remain, you are to annex thereto the Number or Numbers that were cut off from the Dividend, and such new found Number shall be the Remainder. (See Mr *Oughtred's Clavis Mathematica*, cap. 5. 3.) As for Example, Let it be required to divide 46658 by 400; now because there are two Cyphers before the Divisor, I cut off as many Figures from before the Dividend, *viz.* 58, so that then there will remain only 466 to be divided by 4, and the Quotient will be 116, and there will remain 2, to which I annex the two Figures (58 which were cut off from the Dividend, and it makes 258 for the true Remainder; so that I conclude 46658 being divided by 400, the Quotient will be 116; and 258 remain after the Work is ended, as by the Work in the Margent.

```
4|00) 466|58 (116
      4
      6
      4
      26
      24
      (258
```

2. And hence it followeth, that if the Divisor be 1, or an Unit with Cyphers annexed, you may cut off so many Figures from before the Dividend as there are Cyphers in the Divisor, and then the Figure or Figures that are on the left Hand will be the Quotient, and those that are on the right Hand will be the Remainder after the Division is ended. (*Vid. Gem. Fris. Arith, par.* 1.) As thus; if 45783 were to be divided by 10, I cut off the last Figure (3) with a Dash, thus, 4578|3, and the Work is done, and the Quotient is 4578, the Number on the left Hand of the Dash, and the Remainder is 3, on the right Hand. In like manner, if the same Number 45783 were to be divided by 100, I cut off two Figures from the End, thus, 457|83 and the Quotient is 457, and the Remainder is 83. And if I am to divide the same by 1000, I cut off three Figures from the End, thus, 45|783, and the Quotient is 45, and 783 is the Remainder, *&c.*

6. The general Effect of *Division* is contained in the Definition of the same, that is by having two unequal Numbers given, to find a third Number in such Proportion to the Dividend, as the Divisor hath to Unit or 1: It also discovers what Reason or Proportion there is between Numbers, so if you divide 12 by 4, it quotes 3, which shews the Reason or Proportion of 4 to 12 is triple.

The second Effect is, by the superficial Measure or Content, and the Length of any Oblong, Rectangular, Parallelogram, or square Plane known, to find out the Breadth thereby; or contrarywise, by having the Superficies and Breadth

Breadth of the said Figure, to find out the Length thereof. Also by having the Solidity and Length of a Solid, to find the Superficies of the Base, *& contra.*

The third Effect is, by the Contents, Reason, Price, Value, Buying, Selling, Expences, Wages, Exchange, Interest, Profit, or Loss of any Number of Things, be it Money, Merchandize, or what else; to find out the Contents, Reason, Price, Value, Buying, Selling, Expence, Wages, Exchange, Interest, Profit or Loss of any one Thing of the like Kind.

The fourth Effect is, to aid, to compose and to make other Rules, but principally the Rule of Proportion, called the *Golden Rule*, or *Rule of Three*, and the Reduction of Monies, Weights and Measures of one Denomination into another; by it also Fractions are abbreviated, by finding a common Measure unto the Numerator and Denominator, thereby discovering commensurable Numbers.

If you divide the Value of any certain Quantity by the same Quantity, the Quotient discovers the Rate or Value of the Integer; as if 8 Yards of Cloth cost 96 Shillings, if you divide (96) the Value or Price of the given Quantity, by (8) the same Quantity, the Quotient will be 12, which is the Price or Value of 1 of those Yards.

If you divide the Value or Price of any unknown Quantity by the Value of the Integer, it gives you in the Quotient that unknown Quantity, whose Price is thus divided; as if 12 Shillings were the Value of a Yard, I would know how many Yards are worth 96 Shillings: Here if you divide 96, the Price or Value of the unknown Quantity, by 12, the Rate of the Integer, or 1 Yard, the Quotient will be 8, which is the Number of Yards worth 96*s*.

Some Questions answer'd by Division may be these following.

Quest. 1. If 22 Things cost 66 Shillings, what will 1 such Thing cost? *Facit* 3 Shillings; for if you divide 66 by 22, the Quotient is 3 for the Answer. So if 26 Yards or Ells of any Thing be bought or sold for 78*l.* how much will one Yard or Ell be bought or sold for? *Facit* 3*l.* for if you divide 78 by 26 Yards, the Quotient will be 3*l.* the Price of the Integer.

Quest. 2. If the Expence, Charges or Wages of 7 Years amount to 868*l.* what is the Expence, Charges or Wages of one Year? *Facit* 124*l.* for if you divide 868, the Wages of 7 Years, by 7, the Number of Years, the Quotient will be 124*l.* for the Answer. See the Work.

```
7)868(124
  ...
  7
  --
  16
  14
  --
  28
  28
  --
  (0)
```

Quest. 3. If the Content of one superficial Foot be 144 Inches, and the Breadth of a Board be 9 Inches, how many Inches of that Board in Length will make such a Foot? *Facit* 16 Inches; for by dividing 144, the Number of square Inches in a square Foot, by 9, the Inches in the Breadth of the Board, the Quotient is 16 for the Number of Inches in the Length of that Board to make a superficial Foot.

```
9)144(16 Inches
  ..
  9
  --
  54
  54
  --
  (0)
```

Quest. 4. If the Content of an Acre of Ground be 160 square Perches, and the Length of a Furlong (propounded) be 80 Perches, how many Perches will there go in Breadth to make an Acre? *Facit* 2 Perches; for if you divide 160, the Number of Perches in an Acre, by 80, the Length of the Furlong in Perches, the Quotient is 2 Perches, and so many in Breadth of that Furlong will make an Acre.

```
80)160(2 Perches.
   ..
   160
   ---
   (0)
```

Quest. 5. If there be 893 Men to be made up into a Battle, the Front consisting of 47 Men, what Number must there be in the File? *Facit* 19 deep in the File; for if you divide 893, the Number of Men, by 47, the Number in the Front, the Quotient will be 19 in Depth of the File. The Work followeth.

```
47)893(19 deep in File.
   ..
   47
   ---
   423
   423
   ---
   (0)
```

Quest.

Quest. 6. There is a Table whose superficial Content is 72 Feet, and the Breadth of it at the End is 3 Feet; now I demand what is the Length of this Table? *Facit* 24 Feet long; for if you divide 72, the Content of the Table in Feet, by 3, the Breadth of it, the Quotient is 24 Feet for the Length thereof, which was required. See the Operation in the Margent.

```
3)72(24
  6
  12
  12
  (0)
```

The Proof of Multiplication *and* Division.

Multiplication and *Division* interchangeably prove each other; for if you would prove a Sum in *Division*, whether the Operation be right or no, multiply the Quotient by the Divisor, and if any thing remain after Division is ended add it to the Product, which Product, if your Sum was rightly divided, will be equal to the Dividend. And contrarywise, if you would prove a Sum in *Multiplication*, divide the Product by the Multiplier, and if the Work was rightly performed the Quotient will be equal to the Multiplicand. See the Example, where the Work is done and undone. Let 7654 be given to be multiplied by 3242, the Product will be 24814268, as by the Work appeareth.

```
    7654
    3242
   15308
  30616
 15308
22962
24814268
```

And then if you divide the said Product 24814268 by 3242 the Multiplier, the Quotient will be 7654, equal to the given Multiplicand.

```
3242)24814268(7654
     ...
     22694
      21202
      19452
       17506
       16210
        12968
        12968
         (0)
```

In like manner (to prove a Sum or Number in *Division*) if 24814268 were divided by 3242, the Quotient will be found to be 7654; then for Proof, if you multiply 7654 the Quotient, by 3242 the Divisor, the Product will amount to 24814268, equal to the Dividend.

Or, you may prove the last, or any other Example in *Multiplication*, thus, *viz.* divide the Product by the Multiplicand, and the Quotient will be equal to the Multiplier. See the Work.

7654
3242
15308
30616
15308
22962

7654) 24814268 (3242
....

22962
18522
15308
32146
30616
15308
15308
(0)

From whence there arises this Corollary, that any Operation in *Division* may be proved by *Division*; for if, after your Division is ended, you divide the Dividend by the Quotient, the new Quotient thence arising will be equal to the Divisor of the first Operation; for Tryal whereof let the last Example be again repeated.

3242) 24814268) 7654
....

22694
21202
19452
17506
16210
12968
12968
(0)

For Proof whereof divide again 24814268 by the Quotient 7654, and the Quotient hence will be equal to the first Divisor 3242. See the Work.

7654) 24814268 (3242
....

22692
18522
15308
32146
30616
15308
15308
(0)

But

But in proving Division by Division, the Learner is to observe this following Caution; That if after his Division is ended, there be any Remainder, before you go about to prove your Work, subtract the Remainder out of your Dividend, and then work as in the following Example, where it is required to divide 43876 by 765; the Quotient here is 57, and the Remainder is 271. See the Work following.

```
765)43876(57
    ..
    3825
    ----
     5626
     5355
     ----
    (271)
```

Now to prove this Work, subtract the Remainder 271 out of the Dividend 43876, and there remaineth 43605, for a new Dividend to be divided by the former Quotient 57, and the Quotient thence arising is 765, equal to the given Divisor, which proveth the Operation to be right.

```
    43876
      271
    -----
 57)43605(765
    ....
    399
    ---
     370
     342
     ---
      285
      285
      ---
      (0)
```

Thus we have gone through the four Species of *Arithmetick*, viz. *Addition*, *Subtraction*, *Multiplication* and *Division*, upon which all the following Rules, and all other Operations whatsoever that are possible to be wrought by Numbers, have their immediate Dependance, and by them are resolved. (Vide *Gem. Fris.* Arith. par. 1.) Therefore before the Learner make a farther Step in this Art, let him be well acquainted with what has been delivered in the foregoing Chapter.

CHAP. VIII.

Of Reduction.

1. REduction is that which brings together two or more Numbers of different Denominations into one Denomination; (*Hill's* Arith. c. 13. p. 60.) or it serveth to change or alter Numbers, Money, Weight, Measure or Time, from one Denomination to another; and likewise to abridge Fractions to the lowest Terms: All which it doth so precisely, that the first Proportion remaineth without the least Jot of Error or Wrong committed; so that it belongeth as well to Fractions as Integers, of which in the proper Place. *Reduction* is generally performed either by *Multiplication* or *Division*; from whence we may gather, That

2. *Reduction* is either descending or ascending.

3. *Reduction* descending, is when it is required to reduce a Sum or Number of a greater Denomination into a lesser; which Number, when it is so reduced, shall be equal in Value to the Number first given in the greater Denomination; (*Wing.* Arith. 7, 2, 3, 4.) as if it were required to know how many Shillings, Pence or Farthings are equal in Value to 200*l.* or how many Ounces are contained in 45 C. Weight; or how many Days, Hours or Minutes there are in 240 Years, *&c.* And this Kind of *Reduction* is generally performed by *Multiplication.*

4. *Reduction* ascending, is when it is required to reduce or bring a Sum or Number of a smaller Denomination into a greater, which shall be equivalent to the given Number; as suppose it were required to find out how many Pounds, Shillings or Pence are equal in Value to 43785 Farthings; or how many Hundreds are equal to, or in 3748 Pounds, *&c.* And this Kind of *Reduction* is always performed by *Division.*

5. When any Sum or Number is given to be reduced into another Denomination, you are to consider whether it ought to be resolved by the Rule descending or ascending, *&c.* by *Multiplication* or *Division*: If it be to be performed by *Multiplication*, consider how many Parts of the Denomination into which you would reduce it are contain'd in an Unit or Integer of the given Number, and multiply the said given Number thereby, and the Product thereof will be the Answer to the Question. As if the Question were, in 38 Pounds how many Shillings? Here I consider,

consider, that in 1 Pound are 20 Shillings, and that the Number of Shillings in 38*l.* will be 20 times 38, wherefore I multiply 38*l.* by 20, and the Product is 760, and so many Shillings are contained in 38*l.* as in the Margent.

$$\begin{array}{r} 38 \\ 20 \\ \hline 760 \end{array}$$

But when there is a Denomination or Denominations between the Number given and the Number required, you may, if you please, reduce it into the next inferior Denomination, and then into the next lower than that, *&c.* until you have brought it into the Denomination required. As for Example, Let it be demanded in 132 Pounds how many Farthings? First, I multiply 132, the Number of Pounds given, by 20, to bring it into Shillings, and it makes 2640 Shillings, then do I multiply the 2640 Shillings by 12, to bring them into Pence, and it produceth 31680, and so many Pence are contained in 2640 Shillings, or 132 Pounds; then do I multiply the Pence, *viz.* 31680 by 4, to bring them into Farthings (because 4 Farthings is a Penny) and I find the Product thereof to be 126720, and so many Farthings are equal in Value to 132 Pounds. As by the Work in the Margent.

$$\begin{array}{rl} 132 & \text{Pounds} \\ 20 & \\ \hline 2640 & \text{Shil.} \\ 12 & \\ \hline 5280 & \\ 2640 & \\ \hline 31680 & \text{Pence} \\ 4 & \\ \hline 126720 & \text{Farth.} \end{array}$$

6. And if the Number propounded to be reduced is to be divided, or wrought by the Rule ascending, consider how many of the given Number are equal to an Unit or Integer, in that Denomination to which you would reduce your given Number, and make that your Divisor, and the given Number your Dividend: and the Quotient thence arising will be the Number sought or required. As for Example, Let it be required to reduce 2640 Shillings into Pounds. Here I consider that 20 Shillings are equal to one Pound, wherefore I divide 2640, the given Number, by 20, and the Quotient is 132; and so many Pounds are contained in 2640 Shillings. In *Reduction* descending and ascending, the Learner is advised to take particular Notice of the Tables delivered in the second Chapter of this Book, where he may be informed what Multipliers and Divisors to make use of in the reducing of any Number to any other Denomination whatsoever, especially *English* Money, Weights, Measures, Time, and Motion: But in this Place it is not convenient to meddle with foreign Coins, Weights or Measures.

$$\begin{array}{l} \qquad\qquad\quad l. \\ 2\cancel{0})\ 264\cancel{0}\ (132 \\ \quad 2 \\ \hline \quad 0 \\ \quad 6 \\ \hline \quad 4 \\ \quad 4 \\ \hline \quad (0) \end{array}$$

But if, in *Reduction* ascending, it happens that there is a Denomination or Denominations between the Number given and the Number required, then you may reduce your Number given into the next superior Denomination, and when it is so reduced, bring it into the next above that, and so on until you have brought it into the Denomination required. As for Example, Let it be demanded in 126720 Farthings how many Pounds? First, I divide my given Number, being Farthings, by 4, to bring them into Pence, because 4 Farthings make one penny, and there are 31680 Pence; then I divide 31680 Pence by 12, and the Quotient giveth 2640 Shillings; and then I divide 2640 Shillings by 20, and the Quotient giveth 132 Pounds, which are equal in Value to 126720 Farthings. See the whole Work as it followeth.

```
                   12)        2|0)      l.
4)126720      (31680     (264|0     (132
  .....        ....        ..
  12           24          2
  --           --          --
   6           76          6
   4           72          6
  --           --          --
   27           48         4
   24           48         4
  --           --          --
   32          (0)        (0)
   32
  --
  (0)
```

7. When the Number given to be reduced consisteth of diverse Denominations, as *Pounds*, *Shillings*, *Pence* and *Farthings*; or of *Hundreds*, *Quarters*, *Pounds* and *Ounces*, &c. then you are to reduce the highest, or greatest, Denomination into the next inferior, and add thereunto the Number standing in the Denomination which your greatest or highest Number is reduced to; then reduce that Sum into the next inferior Denomination, adding thereto the Number standing in that Denomination; do so until you have brought the Number given into the Denomination proposed.

```
       l.    s.   d.
       48    13   10
       20
      ----------
      960 Shil.
 Add   13
      ----
 Sum  973 Shil.
       12
      ----
     1946
      973
    ---------
    11676 Pence
 Add   10
    ---------
 Sum 11686
```

As if it were required to reduce 48*l.* 13*s* 10*d.* into Pence: First, I bring 48*l.* into Shillings, by multiplying it by 20, and the Product is 960 Shillings, to which I add the 13 Shillings, and they make 973; then I multiply 973 by 12, to

to bring the Shillings into Pence, and they make 11676 Pence, to which I add the 10*d.* and they make 11686 Pence for the Answer. See the Work done.

8. If, in *Reduction* ascending, after Division is ended, any thing remain, such Remainder is of the same Denomination with the Dividend.

Example. In 4783 Farthings, I demand how many Pounds?

First, I divide the given Number of Farthings, *viz.* 4783, by 4, to bring them into Pence, and the Quotient is 1195 Pence, and there remaineth 3 after the Work of Division is ended, which is 3 Farthings.

Again, I divide 1195 Pence (the said Quotient) by 12, to reduce them into Shillings, and the Quotient is 99 Shillings, and there is a Remainder of 7, which is 7 Pence.

And then I divide 99 Shillings (the last Quotient) by 20, to bring it into Pounds, and the Quotient is 4*l.* and there remaineth 19 Shillings; so I conclude that in 4783, the proposed Number of Farthings, there is 4 Pounds, 19 Shillings, 7 Pence, 3 Farthings. View the following Operation.

```
           12)      2|0)
4)4783   (1195    (9|9  (4 Pounds
  ....     ..
  4        108      8
  --       ---     ---
  7        115    (19) Shillings
  4        108
  --       ---
  38  rem. (7) Pence
  36                          l.  s.  d. qrs.
  --                   Facit  4   19  07  3
   23
   20
   --
Rem. (3) Farthings.
```

More Examples in Reduction of Coin.

Quest. 1. In 438*l.* how many Shillings? *Facit* 8760 Shillings; for by multiplying the 438 by 20, the Product amounteth to so much. See the Work in the Margent.

```
       438 l.
        20
      -----
Facit 8760 s.
```

Quest. 2. In 467 *l.* how many Pence? First, multiply the given Number of Pounds (467) by 20, to bring it into Shillings, and it makes 9340 Shillings; then multiply the Shillings by 12, and it produceth 112080 Pence, as in the Margent.

```
         467 Pounds
          20
       ------
        9340
          12
       ------
       18680
        9340
       ------
Facit 112080 Pounds
```

Or

467 Pounds	
240	
18680	
934	
Facit 112080 Pence	

Or it may be resolved thus, *viz.* multiply the given Number of Pounds 467, by 240, the Number of Pence in a Pound, and the Product is the same, *viz.* 112080 Pence as by the Operation appeareth.

Quest. 3. In 5673*l.* how many Farthings? First, multiply the given Number by 20, to bring it into Shillings, and it produceth 113460 Shillings; then multiply that Product by 12, to bring it into Pence, and it produceth 1361520 Pence; then, lastly, multiply the Pence by 4, and it produceth 5446080 Farthings.

	5673 Pounds
	20
	113460 Shillings
	12
	226920
	113460
	1361520 Pence
	4
Facit	5446080 Farthings.

Or this Question might have been thus resolved, *viz.* multiply 5673, the given Number of the Pounds, by 960, the Number of Farthings in a Pound, and it produceth the same Effect, as you may see by the Work.

5673 *Pounds*	20 *Shillings*
960	12
340380	240 *Pence*
51057	4
Facit 5446080 *Farthings*	960 *Farthings.*

Otherwise thus: First bring the given Number 5673 *l.* into Shillings, and multiply the Shillings by 48, the Number of Farthings in a Shilling, and the same Effect is thereby likewise produced, *viz.*

5673 *Pounds*	12 *Pence*
20	4
113460 *Shillings*	48
48	
907680	
453840	
Facit 5446080	

These various Ways of Operation are expressed to inform the Judgment of the Learner with the Reason of the Rule. More Ways may be shewn, but these are sufficient even for the meanest Capacities.

Quest.

Queſt, 4. In 458*l.* 16*s.* 7*d.* 3*qrs.* how many Farthings? To reſolve this Queſtion, conſider the 7th Rule of this Chapter, and work as you are there directed, and you will find the aforeſaid given Number to amount to 440479 Farthings, *viz.*

	l.	*s.*	*d.*	*qrs.*
	458	16	7	3
	20			
	9160			
Add	16	*Shillings*		
Sum	9176	*Shillings*		
	12			
	18352			
	9176			
	110112	*Pence*		
Add	7			
Sum	110119	*Pence*		
	4			
	440476	*Farthings*		
Add	3			
Sum	440479	*Farthings.*		

This laſt Queſtion, or any other of this Kind, may be more conciſely reſolved thus, *viz.* When you multiply the Pounds by 20, to bring them into Shillings, to the Product of the firſt Figure add the Figure ſtanding in the place of Units in the Denomination of Shillings; but becauſe the firſt Figure in the Multiplier is 0, I ſay, 0 times 8 is nothing, but 6 is 6, which I put down for the firſt Figure in the Product, then becauſe the Multiplier is 0, I go on no further with it, for if I ſhould the whole Product will be 0, but proceed; and when I come to multiply by the ſecond Figure in the Multiplier, to the Product of it I add the Figure ſtanding in the Place of Tens in the Denomination of Shillings, which is 1, ſaying, 2 times 8 is 16, and the ſaid Figure 1 is 17; then I ſet down 7, and carry the Unit to the Product of the next Figure, as is directed in the 5th Rule of the 6th Chapter foregoing, and finiſh the Work; ſo that now you may have the whole Product and Sum of Shillings at one Operation, which is the ſame as before: and when you multiply the Shillings by 12, to bring them into Pence after the ſame manner, add to the Product the Number ſtanding in the Denomination of Pence, and ſo when you multiply the Pence by 4, to bring them into Farthings, add to the Product the Number ſtanding under the Denomination of Farthings. See the laſt Queſtion thus wrought.

l. *s.* *d.* *qrs.*
458 16 7 3
20

9176 Shillings
12

18359
9176

110119
4

Facit 440479 Farthings.

After the Method last prescribed are all the following Examples, that are of the same Nature, wrought and resolved.

Quest. 5. In 5375866 Farthings, I demand how many Pounds, Shillings and Pence?

To resolve this Question, First, I divide the given Number of Farthings by 4. and the Quotient is 1093966 Pence, and there remaineth 2 after the Division is ended, which (by the 8th Rule foregoing) is two Farthings; then I divide 1093966 Pence by 12, and the Quotient is 91163 Shillings, and there remaineth 10 after Division, which, by the said 8th Rule is so many Pence, *viz.* 10*d.* then I divide 91163 Shillings by 20, and the Quotient is 4558*l.* and there remaineth 3 Shillings, so the Work is finish'd, and I find that in 4375866 Farthings, there are 4558*l.* 3*s.* 10*d*, 2*qrs.* See the Operation.

12) 2|0) *l.*
4) 4375866 (1093966 (9116|3 (4558

4 108 8

37 13 11
36 12 10

15 19 11
12 12 10

38 76 16
36 72 16

26 46 (3) *s.*
24 36

26 (10) *d.*
24

(2 *qrs.* *l.* *s.* *d.* *qrs.*
Facit 4558 3 10 2

Quest.

Quest. 6. In 4386*l.* I demand how many Groats?

To resolve this Question, I reduce the given Number of Pounds into Shillings, and they are 87720 Shillings; now I consider that in a Shilling are 3 Groats, therefore I multiply the Shillings by 3, and it produceth 263160 Groats. See the Work.

4386 Pounds
20
87720 Shillings
3
Facit 263160 Groats

This Question might have been otherwise resolved thus, *viz.* considering that in a Pound (or 20 Shillings) there are three times 20 Groats, which makes 60, by which I multiply the Number of Pounds given, and it produceth the same Effect at one Operation, as followeth.

4386 Pounds
60 Groats in 20*s.*
Facit 263160 Groats in 4386*l.*

Quest. 7. In 43758 Three-pences, I desire to know how many Pounds?

To resolve this, and many such like Questions, First, I divide my given Number of Three-pences by 4, because 4 Three-pences are in a Shilling, and the Quotient is 10939 Shillings, and there remaineth 2 after Division is ended, which is 2 Three-pences (by the 8th Rule of this Chapter) which are equal in Value to 6*d.* then I divide 10939 Shillings by 20, and the Quotient giveth 546*l.* and 19*s.* remains; so that I conclude in 43758 Pieces, of Three-pence *per* Piece, there are 546*l.* 19*s.* 6*d.* as by the Work appeareth.

```
                2'0       l.   s.  d.
4)43758 (1093'9 (546   19   6
   ....      ...
  4        10
  --       --
   37       9
   36       8
   --      --
    15      13
    12      12
    --      --
     38     19 Shillings
     36
    (2) Three-pences, or 6d.
```

This

This Question might have been otherwise resolved thus, *viz.* First, multiply the given Number of Three-pences, 43758, by 3, the Number of Pence in Three-pence, and the Product, *viz* 131274 is the Number of Pence equal to the given Number of Three-pences, which Number of Pence may be brought into Pounds by dividing by 12, and by 20, and the Quotient you will find to be equal to the former Work, 546*l.* 19*s.* 6*d.*

```
              43758
                  3
          ---------    2|0       l.    s.   d.
        12)131274 (1093|9  (546    19   6
           .....    ...
           12       10
           ---      --
            112      9
            108      8
            ---     --
             47      13
             36      12
            ---     --
             114  re. (19) Shillings
             108
            ---
             (6) pence remains
```

Or thus, Divide the given Number of Three-pences by the Number of Three-pences in a Pound, or 20 Shillings (which you will find to be 80, if you multiply 20*s.* by 4, the Number of Three-pences in a Shilling, and you will find the Quotient to be 546*l.* as before, and a Remainder of 78 Three pences; and if you divide those 78 Three-pences by 4, because there are 4 Three-pences in a Shilling, you will find the Quotient to be 19*s.* and 2 Three-pences remain, which are equal to 6*d.* which is the same that was before found.

```
        8|0)4375|8 (546   19   6          20
            ...                            4
           40                             --
           --                             80
            37
            32
            --
             55
             48
           --------
          4) 78 (19s.
             ..
             4
            ---
             38
             36
            ---
             (2) Three-pences, or 6d.
```

Quest.

Quest. 8. In 4785 *l.* 13 *s.* how many Pieces of 13*d.* $\frac{1}{2}$ *per* Piece?

This Question cannot be resolved by Reduction descending or ascending absolutely, because 13*d.* $\frac{1}{2}$ is no even Part of a Pound, but rather by them jointly, *viz* by Multiplication and Division; but if you bring the Number given into Half-pence, and divide the Half-pence by the Half-pence in 13*d* $\frac{1}{2}$. *viz.* 27, the Quotient will be the Answer: For having brought 4785*l.* 13*s.* into Half-pence, I find it makes 2297112, which I divide by 27, because there are so many Half-pence in 13*d.* $\frac{1}{2}$. and the Quote gives 85078 Pieces of 13*d.* $\frac{1}{2}$, and 6 Half-pence remain over and above. Observe the Work following.

l.	*s.*	*d.*
4785	13	13 $\frac{1}{2}$
20		2
95713 Shillings		27 Half-pence

95713 Shillings
24 Half-pence in a Shilling

382852
191426

2297112 Half-pence is the given Number

27) 2297112 (85078 Pieces of 13*d.* $\frac{1}{2}$

216

137
135

211
189

222
216

Remain (6) Half-pence

It would have produced the same Answer, if you had reduced your given Number into Farthings, and divided by the Farthings in 13*d.* $\frac{1}{2}$, *viz.* 54, (for always the Dividend and the Divisor must be of one Denomination) and then

then you would have had a Remainder of 12 Farthings, which are equal in Value to the former Remainder of 6 Half-pence, as you may prove at your Leisure.

Quest. 9. In 540 Dollars, at 4*s.* 4*d. per* Dollar, how many Pounds sterling?

First, bring your given Number of Dollars into Pence, and then your Pence into Pounds, according to the former Directions, thus, in 4*s.* 4*d viz.* a Dollar, you will find 52 Pence, by which multiply 540 Dollars, and it produceth 28080 Pence, which if you divide by 240, the Pence in one Pound, the Quotient will give you 117*l.* which are equal in Value to 540 Dollars, at 4*s.* 4*d. per* Dollar.

s. *d.*
4 4
12
52

540
52
1080
2700
24|0) 28080 (117
24
40
24
168
168
(0)

The foregoing Question might have been otherwise wrought thus, *viz.* multiply 540, your given Number of Dollars, by 13, the Number of Groats in a Dollar, or 4*s.* 4*d.* and it produceth 7020 Groats, which divide by 60, the Groats in one Pound, or 20 Shillings, and the Quote is 117, as before. See the Work.

s. *d.*
4 4
3
13

540
13
1620
540
6|0) 702|0 (117
6
10
6
42
42
(0)

Quest.

Quest. 10. In 547386 Pieces of 4*d.* ½ *per* Piece, I demand how many Pounds, Shillings and Pence?

First bring your given Number of Four-pence Half-penny all into Half-pence, which you will do if you multiply by 9, the Number of Half-pence in 4*d.* ½, and the Product is 4926474 Half pence, which are brought into Pounds, if you divide them by 24, the Half-pence in a Shilling, and 20, the Shillings in a Pound, it makes 10263*l.* 9*s.* 9*d.*

```
                                          d.
                                          4 ½
     547386                               2
          9                               —
   ————————  2|0                          9 Half-pence
24) 4926474 (2052|69 (10263
    ....... .....
   48          2
   ——         ——
    126        05
    120         4
    ———        ——
      64        12                        l.   s.  d.
      48        12               Facit 10263   9   9
      ——        ——
      167        6
      144        6
      ———       ——
       234 rem (9) Shilings
       216
       ———
```

Remains (18) Half-pence, or 9*d.*

Quest. 11. In 4368*l.* I demand how many Pieces of 6*d.* of 4*d.* and of 2*d.* of each an equal Number? That is to say, What Number of Six-pences, Groats and Two-pences will make 4368*l.* and the Number of each equal?

The Way to resolve Questions of this Nature, is to add the several Pieces into which the given Number is to be brought into one Sum, and reduce the given Number into the same Denomination with their Sum, and to divide the said given Number so reduced by the said Sum, and the Quotient will give you the exact Number of each Piece: And after the same Method will we proceed to resolve the present Question, *viz.*

```
  4386 Pounds                                 6d.
   240 Pence                                  4d.
 ------                                       2d.
175440                                       ----
 8772                                    Sum 12d.
12)1052640(87720
   .....
   96
   --
    92
    84
    --
     86
     84                                    d.  d.  d.
     --           Facit 87720 Pieces of 6   4   2
      24
      24
      --
      (0)
```

So that I conclude by the Operation, that 87720 Six-pences, and 87720 Groats, and 87720 Two-pences, are just as much, or equal to 4386*l.* or if you admit of 5*s.* to be thus divided, it is equal to 5 Six-pences, and 5 Four-pences or Groats, and 5 Two-pences.

Another Question of the same Nature with the last may be this following, *viz.*

Quest. 12. A Merchant is desirous to change 148 *l.* into Pieces of 13*d.* $\frac{1}{2}$, of 12*d.* of 9*d.* of 6*d.* and of 4*d.* and he will have of each sort an equal Number of Pieces, I desire to know the Number?

Do as you were taught in the last Question, *viz.* add the several Pieces together, and reduce the Sum into Half-pence; then reduce the Sum to be changed, *viz.* 148*l.* into the same Denomination, and divide the greater by the lesser, and in the Quotient you will find the Answer, *viz.* 798, which is the Number of each of the Pieces required, and 18 remaineth, which is 18 Half-pence, by the 8th Rule of this Chapter. See the Work as followeth.

l.		*d.*
148		13 ½
240		12
		9
5920		6
269		4
35520 Pence in 148*l.*		Sum 44 ½
2		2
71040 Half-pence		89 Half pence

89) 71040 (798 Pieces of each Sort

623

874
801

730
712

Rem. (18) Half-pence

The Truth of the two foregoing Operations will thus be proved, *viz.* multiply the Anſwer by the Parts or Pieces into which the given Number was reduced, and having added the ſeveral Products together, if their Sum be equal to the given Number the Anſwer is right, otherwiſe not; ſo the Anſwer to the 11th Queſtion was 87720, which is proved as followeth, *viz.*

		l.
87720	Six-pences make	2193
	Four-pences make	1462
	Two-pences make	731

The total Sum of them 4386 which was the Sum given to be changed.

The Anſwer to the 12th Queſtion was 798, and 18 Half pence remained after the Work was ended; now the Truth of the Work may be proved as the former, *viz.*

793

		l.	*s.*	*d.*
798	Pieces of 13*d.* ½ make	44	17	9
	Pieces of 12 make	39	18	0
	Pieces of 9 make	29	18	6
	Pieces of 6 make	19	19	0
	Pieces of 4 make	13	16	0
and 18 Half-pence, or 9*d.* remain		00	00	9
The total Sum of them		148	00	0

which total Sum is equal to the Number that was firſt given to be changed, and therefore the Operation was rightly performed.

Reduction of Troy-weight.

We come now to give the Learner a few Examples in Troy-weight; in working whereof he muſt be mindful of the Table of Troy-weight delivered in the ſecond Chapter of this Book.

Queſt. 13. In 482 lb. 7*oz.* 13 *pwt.* 21 *gr.* how many Grains?

lb	*oz.*	*pwt.*	*gr.*	
482	7	13	21	
12				
971				
482				
5791				Ounces
20				
115833				Penny-weight
24				
463333				
231668				
Fac. 2780013				Grains

Multiply by 12, by 20, and by 24, taking in the Figures ſtanding in the ſeveral Denominations; according to the Direction given in the ſeventh Rule of this Chapter, and you will find the Product to be 2780013 Grains, which is the Number required, or Anſwer to the Queſtion. See the whole Work, as in the Margent.

Queſt. 14 In 2780013 Grains, I demand how many Pounds, Ounces, Penny-weights and Grains?

This is but the foregoing Queſtion inverted, and is reſolved by dividing by 24, by 20, and by 12, and the Anſwer is 482 lb. 7 *oz.* 13 *pwt.* 21 *gr.*

```
              2|0        12
24) 2780013 (11583|3 (5791 (482 lb
    .......   ....     ...
    24        10        48
    ---       ---       ---
     38        15        99
     24        14        96
    ---       ---       ---
     140       18        31
     120       18        24
     ---       ---       ---
      200       3 Rem. 7 Ounces
      192       2
      ---      ---
       81 Rem. 13 Penny-weight
       72
       ---
        93
        72
        ---
Remains 21 Grains
```

	lb	oz.	pwt.	gr.
Facit	482	7	13	21

Quest. 15. A Merchant sent to a Goldsmith 26 Ingots of Silver, each containing in Weight 2 lb. 4 *oz.* and ordered it to be made into Bowls of 2 lb 8 *oz. per* Bowl, and Tankards of 1 lb 6 *oz. per* piece, and Salts of 10 *oz.* 10 *pwt. per* Salt, and Spoons of 1 *oz* 18 *pwt. per* Spoon, and of each an equal Number; I desire to know how many of each sort he must make?

This Question is of the same Nature with the 11th and 12th Questions foregoing, and may be answered after the same Method, *viz.* First, add the Weight of the several Vessels into which the Silver is to be made into one Sum, and reduce it to one Denomination, and they make 1248 Penny-weights; then reduce the Weight of the Ingot into the same Denomination, *viz.* Penny weights, and it makes 560 Penny weights, and multiply them by the Number of Ingots, *viz.* 16, and the Product will give you the Weight of the 16 Ingots, *viz.* 8960; then divide the Product by the Weight of the Vessels, *viz* 1248, and the Quotient giveth you the Answer to the Question, *viz.* 7, and 224 *pwt.* remaineth over and above.

2 lb

lb	oz.	
2	4	
12		
28		
20		
560	Penny-weights	
16	Ingots	
3360		
560		
1248) 8960 (7	Vessels of each	
8736		
Rem. 224	Penny weights	

	lb	oz.	pwt.
	2	08	00
	1	06	00
	0	10	10
	0	01	18
Sum	5	02	08
	12		
	62		
	20		
	1248		

The Proof of the Work is as followeth, viz.

							lb	oz.	pwt.
7	Bowls	of 2	08	00	*per* Bowl,	is	18	08	00
7	Tankards	of 1	06	00	*per* Tank.	is	10	06	00
7	Salts	of 0	10	10	*per* Salt,	is	06	01	10
7	Spoons	of 0	01	18	*per* Spoon,	is	01	01	06
		224	Penny-weight remaining				00	11	04
							37	04	00

So that you see the Sum of the Weight of each Vessel, together with the Remainder, is 37lb 4oz, which is equal to the Weight of the 16 Ingots delivered; for if 37lb 4oz. be reduced to Penny-weight, it makes 8960.

Reduction of Averdupois-weight.

In reducing Averdupois weight, the Learner must have Recourse to the Table of Averdupois-weight, delivered in the second Chapter.

Quest.

Quest. 16. In 47*C.* 1*qr.* 20lb how many Ounces? Multiply by 4, by 28, and 16, and the last Product will be the Answer, *viz.* 84992 Ounces. See the Margent.

```
C.  qr.  lb
47   1   20
 4
---
189 Quarters
 28
----
1512
380
----
5312 l.
  16
----
31872
5312
-----
Facit 84992 Ounces
```

Quest. 17. In 84992 Ounces, I demand how many *C. qrs.* lb and *oz.*

This is the foregoing Question inverted, and will be resolved, if you divide by 16. by 28. and by 4, and the Answer is 47*C.* 1*qr.* 20lb equal to the given Number in the foregoing Question.

```
            28)     4)     C   qr.  lb  oz.
16) 84992 (5312  (189  (47    1    20  00
    ....   ...     ..

    80      28     16
    --      --     --
    49     251     29
    48     224     28
    --     ---     --
     19    272    (1) qr.
     16    152
     --    ---
      32  (20) lb
      32
      --
      (0)
```

Reduction of Liquid Meaſure.

Queſt. 18. In 45 Tuns of Wine, how many Gallons? Multiply by 4. and by 63, the Product is 11340 Gallons for the Anſwer.

$$\begin{array}{r} 45 \\ \underline{4} \\ 180 \\ \underline{63} \\ 540 \\ 1080 \\ \hline \end{array}$$

Facit 11340 Gallons

Queſt. 19. In 34 Rundlets of Wine, each containing 18 Gallons, I demand how many Hogſheads?

Firſt, find how many Gallons are in the 34 Rundlets, which you may do if you multiply 34 by 18, the Content of a Rundlet, and the Product is 612 Gallons, which you may reduce into Hogſheads, if you divide them by 63, and the Quote will be 9 Hogſheads and 45 Gallons. See the Work.

$$\begin{array}{r} 34 \\ \underline{18} \\ 272 \\ \underline{34} \\ 63)612(9 \text{ hhds.} \\ 567 \\ \hline \end{array}$$

Facit 9 hhds, 45 Gal.

Rem. 45 Gallons.

Queſt. 20. In 12 Tun, how many Rundlets of 14 Gallons *per* Rundlet.

Reduce your Tuns into Gallons, and divide them by 14, the Gallons in a Rundlet, and the Quotient 216, is your Anſwer. See the Work following.

$$\begin{array}{r} 12 \\ \underline{4} \\ 48 \\ \underline{63} \\ 144 \\ \underline{288} \\ 14)\,3024\,(216 \text{ Rundlets} \\ 28 \\ \hline 22 \\ \underline{14} \\ 84 \\ \underline{84} \\ (0) \end{array}$$

Facit 216 Rundlets.

Reduction of Long Measure.

Quest. 21. I demand how many Furlongs, Poles, Inches and Barly-corns will reach from *London* to *York*, it being accounted 151 Miles?

151 Miles
8 Furlongs in a Mile
1208 Furlongs
40 Poles in a Furlong
48320 Poles
11 Half-yards in a Pole
48320
48320
531520 Half-yards
18 Inches in half Yard
4252160
531520
9567360 Inches
3 Barly-corns in one Inch
Facit 28702080 Barly-corns in 151 *English* Miles.

Quest. 22. The Circumference of the Earth (as all other Circles are) is divided into 360 Degrees, and each Degree into 60 Minutes, which (upon the Superficies of the Earth) are equal to 60 Miles; now I demand how many Miles, Furlongs, Perches, Yards, Feet and Barly-corns will reach round the Globe of the Earth?

360 Degrees
60 Minutes or Miles in a Degree
21600 Miles about the Earth
8 Furlongs in a Mile
172800 Furlongs about the Earth
40 Perches in a Furlong
6912000 Poles or Perches about the Earth
11 Half-yards in a Perch
6912000
6912000
2)76032000 Half-yards upon the Earth
)38016000 Yards, *viz.* the Half-yards divided by 2
3
114048000 Feet about the Earth
12 Inches in a Foot
228096000
114048000
1368576000 Inches about the Earth
3 Barly-corns in an inch
Fa. 4105728000 Barly-corns

And so many will reach round the World, the whole being about 21600 Miles; so that if any Person were to go round, and go 15 Miles every Day, he would go the whole Circumference in 1440 Days, which is 3 Years, 11 Months, and 15 Days.

Reduction of Time.

Quest. 23. In 28 Years, 24 Weeks, 4 Days, 16 Hours, 30 Minutes, how many Minutes?

```
 Years Weeks Days Hours Min.
    28    24    4    16   30
    52 Weeks in a Year.
   ---
    60
   142
  ----
  1480 Weeks
     7
 -----
 10364 Days
    24
 -----
 41462
20729
------
248752 Hours
    60
-------
14925150 Minutes
```

Note, That in resolving the last Question after the Method expressed, there is lost in every Year 30 Hours; for the Year consisteth of 365 Days and 6 Hours, but by multiplying the Year by 52 Weeks, which is but 364 Days, you lose 1 Day and 6 Hours every Year; wherefore to find an exact Answer, bring the odd Weeks, Days and Hours into Hours, and then multiply the Years by the Number of Hours in the Year, *viz.* 8766, and to the Product add the Hours contained in the odd Time, and you have the exact Time in Hours, which bring into Minutes as before. See the last Question thus resolved:

Weeks

	Weeks	Days	Hours
	24	4	16
	7		
	172		
	24		
	694		
	346		
	4144 Hours		

	Days	Hours
28	365	6
8766	24	
172	1466	
172	730	
197	8766 Hours in a Year	
228		
249592 Hours		
60		

14975520 Minutes in 28 Years, and 4144 Hours, 30 Minutes.

So you see that according to the Methods first used to resolve this Question, the Hours contained in the given Time are 248752; but according to the last, best, or truest Method, they are 249592, which exceeds the former by 840 Hours.

But for most Occasions it will be sufficient to multiply the given Years by 365, and to the Product add the Days in the odd Time, if there be any, and then there will be only a Loss of 6 Hours in every Year, which may be supplied by taking a fourth Part of the given Years, and adding it to the contained Days, and you have your Desire.

Quest. 24. In 438657540 Minutes, how many Years? *Facit* 834 Years, 4 Days, 19 Hours.

		Years	Days	Hours
	8766			
6|0)43865754|0(7310959		834	4	19
42	70128			
18	29815			
18	26298			
6	35179			
6	35064			
57	24)115(4 Days			
54				
35	96			
30 Rem.	(19) Hours			
54				
54				
(0)				

Quest. 25. I desire to know how many Hours and Minutes it is since the Birth of our Saviour *Jesus Christ*, being accounted 1751 Years?

This Queſtion is of the ſame Nature with the 24th foregoing, and after the ſame Manner is reſolved, *viz.* multiply the given Number of Years by 8766, the Product is 15349266 Hours, and that by 60, and the Product is 920955960 Minutes. See the Work.

```
      1751 Years
      8766 Hours in a Year
     -----
     10506
    10506
   12257
  14008
 --------
  15349266 Hours in 1751 Years
        60
 ---------
 920955960 Min, in 1751 Years
```

Note, That as Multiplication and Diviſion do interchangeably prove each other, ſo Reduction deſcending and aſcending prove each other by inverting the Queſtion, as the 13th and 14th, and likewiſe the 16th and 17th Queſtions foregoing, by Inverſion, do interchangeably prove each other. The like may be performed for the proof of any Queſtion in Reduction whatſoever.

CHAP. IX.

Of Comparative Arithmetick, viz. *the Relation of Numbers one to another.*

1. Comparative Arithmetick is that which is wrought by Numbers, as they are conſidered to have Relation one to another, and this conſiſts either in Quantity or in Quality. *Vide* Boetius's *Arith, lib.* 1. *cap.* 21.

2. Relation of Numbers in Quantity, is the Reference or Reſpect that the Numbers themſelves have to one another, where the Terms or Numbers propounded are always two, the firſt called the Antecedent, and the other the Conſequent. *See* Wing. *Arithm.*

3. The Relation of Numbers in Quantity conſiſts in the Differences, or in the Rate or Reaſon that is found betwixt the Terms propounded, the Difference of two Numbers being the Remainder found by Subtraction (according to *Alsted*) but the Rate or Reaſon betwixt two Numbers is the Quotient of the Antecedent divided by the Conſequent; ſo 21 and 7 being given, the Difference betwixt them will be found to be 14, but the Rate or Reaſon that is betwixt 21 and 7 will be found to be triple Reaſon, for 21 divided by 7 quotes 3, the Reaſon or Rate.

4. The

4. The Relation of Numbers in Quality (otherwise called Proportion) is the Reference or Respect that the Reason of Numbers have one unto another; therefore the Terms given ought to be more than two. Now this Proportion or Reason between Numbers relating one to another, is either Arithmetical or Geometrical.

5. Arithmetical Proportion is, when diverse Numbers differ one from another by equal Reason, that is, have equal Differences, (by some called Progression.)

So this Rank of Numbers, 3, 5, 7, 9, 11, 13, 15, 17, differ by equal Reason, *viz.* by 2, as you may prove.

6. In a Rank of Numbers that differ by Arithmetical Proportion, the Sum of the first and last Term being multiplied by half the Number of Terms, the Product is the total Sum of all the Terms.

Or, if you multiply the Number of Terms by the half Sum of the first and last Terms, the Product is the total Sum of all their Terms.

So in the former Progression given, 3 and 17 is 20, which multiplied by 4, *viz.* half the Number of Terms, the Product gives 80, the Sum of all the Terms: Or multiply 8 (the Number of Terms) by 10, half the Sum of the first and last Terms; the Product gives 80 as before.

So also 21, 18, 15, 12, 9, 6, 3, being given, the Sum of all the Terms will be found to be 84; for here the Number of Terms is 7, and the Sum of the first and last, (*viz.* 21 and 3) is 24, half whereof (*viz.* 12) multiplied by 7, produceth 84, the Sum of the Terms sought.

7. Three Numbers that differ by Arithmetical Proportion, the Double of the Mean (or middle Number is equal to the Sum of the Extremes.

So 9, 12 and 15 being given, the Double of the Mean 12 (*viz.* 24) is equal to the Sum of the two Extremes, 9 and 15.

8. Four Numbers that differ by Arithmetical Proportion (either continued or interrupted) the Sum of the two Means is equal to the Sum of the two Extremes.

So 9, 12, 18, 21, being given, the Sum of 12 and 18 will be equal to the Sum of 9 and 21, *viz.* 30: Also, 6, 8, 14, 16, being given. the Sum of 8 and 14 is equal to the Sum of 6 and 16, *viz.* 22, *&c.* *See* Wingate's *Arith. c.* 35.

9. Geometrical Proportion (by some called Geometrical Progression) is when diverse Numbers differ, according to like Reason.

So 1, 2, 4, 8, 16, 32, 64, *&c.* differ by double Reason, and 3, 9, 27, 81, 243, 729, differ by triple Reason; 4, 16, 64, 256, *&c.* differ by quadruple Reason, *&c.*

10. In any Numbers that increaſe by Geometrical Proportion, if you multiply the laſt Term by the Quotient of any one of the Terms divided by another of the Terms which being leſs is next unto it, and having deducted or ſubtracted the firſt Term out of that Product, divide the Remainder by a Number that is an Unit leſs than the ſaid Quotient, the laſt Quote will be the Sum of all the Terms.

```
         64
   4)  8 (2
        128
          1
1) 127 (127
```

So 1, 2, 4, 8, 16, 32, 64, being given, firſt I take one of the Terms, *viz.* 8, and divide it by the Term which is leſs, and next to it, (*viz.* by 4) and the Quotient is 2, by which I multiply the laſt Term 64, and the Product is 128, from whence I ſubtract the firſt Term (*viz.* 1) the Remainder is 127, which divided by the Quotient 2 made leſs by 1, *viz.* 1, the Quote is 127, for the Sum of all the given Terms, as by the Work in the Margent.

```
     1024
16)  64 (4
     4096
        4
3) 4092 (1364
```

So if 4, 16, 64, 256, 1024, were given the Sum of all the Terms will be found to be 1364. For firſt I divide 64, one of the Terms, by the next leſſer Term, and the Quotient is 4, by which I multiply the laſt Term 1024, and it produceth 4096; from whence I ſubtract the firſt Term 4, and the Remainder is 4092, which I divide by the Quote leſs by 1, *viz.* 3, and the Quote is 1364, for the total Sum of all the Terms, as *per* Margent.

11. Three Geometrical Proportionals given, the Square of the Mean is equal to the Rectangle, or Product of the Extremes.

So 8, 16, 32, being given, the Square of the Mean, *viz.* 16, is 256, which is equal to the Product of the Extremes 8 and 32, for 8 times 32 is equal to 256.

12. Of four Geometrical proportionable Numbers given, the Product of the two Means is equal to the Product of the two Extremes.

So 8, 16, 32, 64, being given, I ſay, that the Product of the two Means, *viz.* 16 times 32, which is 512, is equal to 8 times 64, the Product of the Extremes.

Alſo if 3, 9, 21, 63 were given, which are interrupted, I ſay, 9 times 21 is equal to 3 times 63, which is equal to 189.

From hence ariſeth that precious Gem in Arithmetick, which for the Excellency thereof is called the *Golden Rule*, or *Rule of Three*.

CHAP.

CHAP. X.

The Single Rule of Three Direct.

THE Rule of Three (not undeſervedly called the Golden Rule) is that by which we find out a fourth Number in Proportion unto three given Numbers, ſo as this fourth Number that is ſought may bear the ſame Rate, Reaſon and Proportion to the third (given) Number as the ſecond doth to the firſt; from whence it is alſo called the *Rule of Proportion.*

2. Four Numbers are ſaid to be proportional when the firſt containeth, or is contained by the ſecond, as often as the third containeth, or is contained by the fourth. *Vide* Wingate's *Arith. Chap.* 8. *Sect.* 4.

So theſe Numbers are ſaid to be Proportionals, *viz.* 3, 6, 9, 18, for as often as the firſt Number is contained in the ſecond, ſo often is the third contained in the fourth, *viz.* twice: Alſo 9, 3, 15, 5, are ſaid to be Proportionals; for as often as the firſt Number containeth the ſecond, ſo often the third Number containeth the fourth, *viz.* 3 times.

3. The Rule of Three is either ſimple or Compound.

4. The ſimple (or ſingle) Rule of Three conſiſteth of four Numbers, that is to ſay, it hath three Numbers given to find out a fourth; and this is either Direct or Inverſe. *Vide* Alſted. *Math. lib.* 2. *c.* 13.

5. The ſingle Rule of Three Direct, is when the Proportion of the firſt Term is to the ſecond, as the third is to the fourth; or when it is required that the Number ſought, *viz.* the fourth Number, muſt have the ſame Proportion to the ſecond, as the third hath to the firſt.

6. In the Rule of Three, the greateſt Difficulty is to diſcover the Order of the 3 Terms of the Queſtion propounded, *viz.* which is the firſt, ſecond, and the third; which that you may underſtand, obſerve, that of the three given Numbers, two always are of one Kind, and the other is of the ſame Kind with the proportional Number that is ſought; as in this Queſtion, *viz.* If 4 Yards of Cloth coſt 12 Shillings, what will 6 Yards coſt at that Rate? Here the two Numbers of one Kind are 4 and 6, *viz.* they both ſignify ſo many Yards, and 12*s.* is the ſame Kind with the Number ſought, for the Price of 6 Yards is ſought.

Again obſerve, That of the three given Numbers, thoſe two that are of the ſame Kind, one of them muſt be the firſt, and the other the third, and that which is of the

ſame Kind with the Number ſought, muſt be the ſecond Number in the Rule of Three. And that you may know which of the ſaid Numbers to make your firſt, and which your third, know this, that to one of thoſe two Numbers there is always affixed a Demand, and that Number upon which the Demand lieth, muſt always be reckoned the third Number. As in the forementioned Queſtion, the Demand is affixed to the Number 6; for it is demanded, what 6 Yards will coſt, and therefore 6 muſt be the third Number, and 4 (which is of the ſame Denomination or Kind with it) muſt be the firſt, and conſequently the Number 12 muſt be the ſecond; and then the Numbers being placed in the forementioned Order, will ſtand as followeth, *viz.*

Yards	*s.*	*Yards*
4	12	6

7. The next Thing is, to find out the fourth Number in Proportion; which that you may do, multiply the ſecond Number by the third, and divide the Product thereof by the firſt, or (which is all one) multiply the third Term (or Number) by the ſecond, and divide the Product thereof by the firſt, and the Quotient thence ariſing is the 4th Number in a direct Proportion, and is the Number ſought, or Anſwer to the Queſtion, and is of the ſame Denomination that the ſecond Number is of; as thus, let the ſame Queſtion be again repeated, *viz.* If 4 Yards of Cloth coſt 12 Shillings, what will 6 Yards coſt?

Having placed my Numbers according to the 6th Rule (of this Chapter) foregoing, I multiply the ſecond Number 12, by the third Number 6, and the Product is 72, which Product I divide by the firſt Number 4, and the Quotient thence ariſing is 18, which is the fourth Proportional or Number ſought, *viz.* 18 Shillings, (becauſe the ſecond Number is Shillings) which is the Price of 6 Yards, as was required by the Queſtion. See the Work following.

	Yards		*s.*		*Yards*		*s.*
If	4	:	12	: :	6	:	18

```
         12
          6
        ----
       4) 72 (18 Shillings
          4
          --
          32
          32
          (0)
```

Queſt.

Quest. 2. Another Question may be this, *viz.* If 7 C. of of Pepper cost 21*l* how much will 16 C. cost at that Rate?

To resolve which Question I consider that (according to the 6th Rule of this Chapter) the Terms or Numbers ought to be placed thus, *viz.* the Demand lying upon 16C. it must be the third Number, and that of the same Kind with it must be the first, *viz.* 7C.; and 21*l*. (being of the same Kind with the Number sought) must be the second Number in this Question; then I proceed according to this 7th Rule, and multiply the second Number by the third, *viz.* 21 by 16, and the Product is 336, which I divide by the first Number 7, and the Quotient is 48*l*. which is the Value of 16C. of Pepper at the Rate of 21*l*. for 7C. See the Work following.

```
C.     l.     C.
7      21     16
       16
      ---
      126
      21
     ----
  7)336(48 l.
   28
   --
    56
    56 Facit 48 l.
    --
   (0)
```

8. If when you have divided the Product of the second and third Numbers by the first, any Thing remain after Division is ended, such Remainder may be multiplied by the Parts of the next inferior Denomination, that are equal to an Unit (or Integer) of the second Number in the Question, and the Product thereof divide by the first Number in the Question, and the Quotient is of the same Denomination with the Parts by which you multiplied the Remainder, and is Part of the fourth Number which is sought. And furthermore, if any Thing remain after this last Division is ended, multiply it by the Parts of the next inferior Denomination, equal to an Unit of the last Quotient, and divide the Product by the same Divisor, (*viz.* the first Number in the Question, and the Quote is still of the same Denomination with your Multiplier; follow this Method until you have reduced your Remainder into the lowest Denomination, *&c.* An Example or two will make this Rule very plain, which may be the following.

Quest.

Quest. 3. If 13 Yards of Velvet, *&c.* cost 21*l.* what will 27 Yards of the ſame coſt at that Rate?

Having ordered and wrought my Numbers according to the 6th and 7th Rules of this Chapter, I find the Quotient to be 43*l.* and there is a Remainder of 8, ſo that I conclude the Price of 27 Yards to be more than 43*l.* and to the Intent that I may know how much more, I work according to the foregoing Rule, *viz* I multiply the ſaid Remainder 8 by 20*s.* (becauſe the ſecond Number in the Queſtion was Pounds) and the Product is 160, which divided by the firſt Number, *viz.* 13, it quotes 12, which are 12 Shillings, and there is yet a Remainder of 4, which I multiply by 12 Pence. (becauſe the laſt Quotient was Shillings) and the Product is 48, which I divide by 13 (the firſt Number) and the Quotient is 3*d.* and yet there remaineth 9, which I multiply by 4 Farthings, and and the Product is 36, which divided by 13 again, it quotes 2 Farthings, and there is yet a Remainder of 10, which (becauſe it cometh not to the Value of a Farthing) may be neglected, or rather ſet after the 2 Farthings over the Diviſor with a Line between them, and then (by the 21ſt and 22d Definitions of the firſt Chapter of this Book) it will be $\frac{10}{13}$ of a Farthing; ſo that I conclude, that if 13 Yards of Velvet coſt 21*l.* 27 Yards of the ſame will coſt 43*l.* 12*s.* 3*d.* $2\frac{10}{13}$*qrs.* which Fraction is 10 Thirteenths of a Farthing. See the Operation as followeth.

If

yds. *l.* *yds.*
If 13 21 27
27

147
42

13) 567 (43 *l.*

52

47
39

Remain (3)
Multiply 20

13) 160 (12 *s.*

13

30
26

Remain (4)
Multiply 12

13) 48 (3 *d.*
39
Remain (9)
Multiply 4
qrs.
13) 36 ($2\frac{10}{13}$
26

		l.	*s.*	*d.*	*qrs.*
Remain 10	*Facit*	43	12	3	$2\frac{10}{13}$

Quest. 4. Another Example may be this following, *viz.* If 14 Pounds of Tobacco cost 27*s* what will 478 Pound cost at that Rate?

Work

Work according to the last Rule, and you will find it to amount to 921*s.* 10*d.* $1\frac{2}{14}$*qrs.* and by the 5th Rule of the 8th Chapter 921*s.* may be reduced to 46*l.* 1*s.* so that then the whole Worth or Value of the 478*l.* will be 46*l.* 1*s.* 10*d.* $1\frac{2}{14}$*qrs.* The Work followeth.

```
       l.   s.    l.
   If 14 : 27 :: 478
                   27
                 ----
                 3346
                 956
                 ----
                      2|0
     14)12906)92|1(46l.
          126    8
          ---   ---
           30    12
           28    12
          ---   ---
           26    (1)
           14
          ---
Remains   (12)
Multiply   12
          ---
           24
           12
          ---
       14) 144(10d.
           14
          ---
Remains   (4)
Multiply   4
          ---
           14
       14) 16 (1 2/14
          ---
Remains   (2)
```

Facit 46*l.* 1*s.* 10*d.* $1\frac{2}{14}$*qrs.*

9. In

9. In the Rule of Three it many times happens, that altho' the first and third Numbers be of one Kind, as both Money, Weight, Measure, *&c.* yet they may not be of one Denomination, or perhaps they may both consist of many Denominations; in which Case you are to reduce both Numbers to one Denomination, and likewise your second Number (if it consisteth at any time of diverse Denominations) must be reduced to the least Name mentioned, or lower if you please; which being done, multiply the second and third together, and divide by the first, as is directed in the 7th Rule of this Chapter.

And note, that always the Answer to the Question is in the same Denomination that your second Number is of, or is reduced to, as was hinted before.

Quest. 5. If 15 Ounces of Silver be worth 3*l.* 15*s.* what are 86 Ounces worth at that Rate?

In this Question the Numbers being ordered according to the 6th Rule of this Chapter, the first and third Numbers are Ounces, and the second Number is of diverse Denominations, *viz.* 3*l*, 15*s.* which must be reduced to Shillings, and the Shillings multiplied by the third Number, and the Product divided by the first, gives you the Answer in Shillings, *viz.* 430 Shillings, which are reduced to 21*l.* 10*s.*

```
       oz.      l.  s.      oz.
  If   15   :   3   15  ::  86
                20
              ----
                75
                86
              ----
               450
              600
          ----------20  l.  s.
       15) 6450 (43|0 (21  10
              ...
              60      4
              --     --
              45      3
              45      2
              --     --
              (0)    (10) s.
```

In resolving the last Question, the Work would have been the same if you had reduced your second Number into Pence, for then the Answer would have been 5160 Pence, equal to 21*l.* 10*s.* or if you had reduced the second Number into Farthings, the Quotient or Answer would have been 20640 Farthings, equal to the same, as you may prove at your Leisure.

Quest.

Quest. 6. If 8lb of Pepper cost 4*s.* 8*d.* what will 7C. 3*qrs.* 14lb cost?

In this Question the first Number is 8lb and the third is 7*C.* 3*qrs.* 14lb which must be reduced to the same Denomination with the first, *viz.* into Pounds, and the second Number must be reduced into Pence; then multiply and divide according to the 7th Rule foregoing, and you will find the Answer to be 6174 Pence, which is reduced into 25*l.* 14*s.* 6*d.*

```
    lb        s. d.             C. qrs.   lb
If   8  cost  4  8  what will   7   3    14 cost?
             12                 4
            ---               ----
             56                31
                               28
                              ----
                              252
                              63
                              ----
                              882
                               56 second Number.
                             -----
                             5292
                            4410
                        ---------- 12)     2|0)    l.  s.  d.
                        8) 49392 (6174  (51|4  (25  14  6
                           ....    ..     ..
                          48       60       4
                          ---     ---     ---
                           13      17      11
                            8      12      10
                          ---     ---     ---
                           59      54     (14) s.
                           56      48
                          ---     ---
                           31     (6) d.
                           32
                          ---            l.   s.   d.
                          (0)   Facit   25   14    6
```

Quest.

Quest. 7. If 3*C.* 1*qr.* 14lb of Raisins cost 9*l.* 9*s* what will 6*C.* 3*qrs.* 20lb of the same cost?

Here the first and third Numbers each consist of diverse Denominations, but must be brought both into one Denomination, &c as you see in the Operation that followeth. The Answer is 388*s.* which is reduced into 19*l.* 8*s.*

C. qr. lb — l. s. — C. qrs. lb

If 3 1 14 cost 9 9 what will 6 3 20 cost?

4 — 20 — 4

13 — 189 — 27

28 — 28

108 — 216

27 — 56

378 Pounds — 776 Pounds

189 second Number.

6984

6208

776

20 — l. s.

378) 146664) 388 (19 8

1134 — 2

3326 — 18

3024 — 18

3024 — (8)

l. s. 3024

Facit 19 8

(0)

Quest. 8. If in 4 Weeks I spend 13*s.* 4*d.* how long will 53*l.* 6*s.* last me at that Rate?

Answer 2238 Days, equal to 6 Years, 48 Days. See the Work.

If

	s.	*d.*		*W.*		*l.*	*s.*	
If	13	4	require	4	what will	53	6	require ?
	12			7		20		
	30			28	Days	1066		
	13					12		
	160					2132		

1066

12792 Pence
28 second Number.

102336
25584

16|0)35817|6 (2238 (6 Years.
365
2190

Rem. (48) Days

32
38
32
61
48
137
128

Remains (96)

Years *Days*
Facit 6 $48\frac{96}{160}$

Quest. 9. Suppose the yearly Rent of a House, a yearly Pension, or Wages, be 73*l*. I desire to know how much it is *per* Day?

Here you are to bring the Year into Days, and say, if 365 Days require 73*l*. what will one Day require?

Now when you come to multiply 73 by 1, the Product is the same, for 1 neither multiplieth nor divideth; and 73 cannot be divided by 365, because the Divisor is bigger than the Dividend; wherefore bring the 73*l*. into Shillings, and they make 1460, which divide by the first Number, 365, and the Quote is 4 Shillings for the Answer; as you see in the Work.

Days

Days	*l.*	*Day*
If 365	73	1

```
               73
               20
      365)1460(4 s.
          1460
          ----   Facit 4s. per Day.
           (0)
```

Quest. 10. A Merchant bought 14 Pieces of Broad-cloth, each Piece containing 28 Yards, for which he gave after the Rate of 13s 6d ½ per Yard, now I desire to know how much he gave for the 84 Pieces at that Rate?

First find out how many Yards are in the 14 Pieces, which you will do if you multiply the 14 Pieces by 28 (the Number of Yards in a Piece) and it makes 392; then say, if 1 Yard cost 13s. 6d. ½ what will 392 Yards cost? Work as followeth, and the Answer you will find to be 127400 Half-pence, which reduced makes 265l. 8s. 4d. for after you have multiplied your second and third Numbers together, the Product is 127400, which (according to the seventh Rule) should be divided by the first Number; but the first Number is 1, which neither multiplieth nor divideth, and therefore the Quotient, or fourth Number, is the same with the Product of the second and third, which is in Half-pence, because the second Number was so reduced. See the Work as followeth.

```
                     28
                     14
                    ---
                    112
                    28
                    ---
                    392 Yards in the 14 Pieces.
 Yd.      s.   d.       Yds.
If 1 cost 13   6½, what will 392 cost?
          12                325 the second Number.
          --              -----
          32               1960
          13               784
          --              1176
         162              ------ 2|0
           2           24)127400(530|8(265l.
Half-pence 325            ....   ...
                          120     4
                          ---     --
                           74     13
                           72     12
                          ---     --
                           200    10
Facit 265l. 8s. 4d.        192    10
                          ---    ---
                   Remains (8)   (8) Shillings
                   Half-pence, or 4d.
```

Quest.

Quest. 11. A Draper bought 420 Yards of Broad-cloth, and gave for it after the Rate of 14*s.* 10*d.* $\frac{3}{4}$ *per* Ell *English*, now I demand how much he paid for the Whole after that Rate?

Bring your Ells into Quarters, and your given Yards into Quarters; the Ell is 5 Quarters, and in 420 Yards are 1680 Quarters; then say if 5 Quarters cost 14*s.* 10*d.* $\frac{3}{4}$ (or 715 Farthings) what will 1680 Quarters cost? *Facit* 250*l.* 5*s.* See the Operation.

Ells 1, 5, 5   *Yards* 420, 4, 1680 *qrs.*

qrs.		*s.*	*d.*		
If 5	:	14	10 $\frac{3}{4}$	: :	1680
		12			715
		28			8400
		15			1680
		178 *d.*			11760
		4			96|0
		715 *qrs.*			5) 1201200 (24024|0 (250*l.*

10, 20, 20, 12, 10, 20, 20, (0)   192, 482, 480, rem. (240) *qrs.* or 5*s.*

	l.	*s.*	*d.*
Facit	250	5	0

Quest. 12 A Draper bought of a Merchant 50 Pieces of Kersey, each Piece containing 34 Ells *Flemish* (the Ell *Flemish* being three Quarters of a Yard) to pay after the Rate of 8*s.* 4*d.* *per* Ell *Flemish*; I demand how much the 50 Pieces cost him at that Rate?

First find out how many Ells *Flemish* are in the 50 Pieces, by multiplying 50 by 34, the Product is 1700, which bring into Quarters by 3, it makes 5100 Quarters; then proceed as in the last Question, and the Answer you will find to be 102000 Pence, or 425*l.* See the Operation as followeth.

If

```
     qrs.     s.    d.       qrs.
If   5   :    8     4  : :   5100              50
              12             100               34
            ----           -------- d.       -----
            100 d,     5) 510000 (10200       200
                          .....              150
                          5                  ------
                        ----                 1700 Ells Fl.
                          10                    3
                          10                 ------
                         ----                5100
                          (0)      (2|0
                    12) 102000 (850|0 (425 l.
                          ...      ..
                         96        8
                        ----      ---
                         60        5
                         60        4
                        ----      ---
                         (0)       10
                                   10
                                  ----
       Facit 425 l.                (0)
```

Quest. 13. A Goldsmith bought a Wedge of Gold which weighed 14 lb 3 *oz.* 8 *pwt.* for the Sum of 514 *l.* 4 *s.* I demand what it stood him in *per* Ounce? *Answer* 60 *s.* or 3 *l.*

```
     lb   oz.   pwt.              l.      s.     oz.
If   14   3     8        :       514      4  : :  1
     12                           20 Shil.        20
    ----                        -------          ----
     31                          10284           20 pwt.
     14                           20 pwt.
    ----                        -------- 2|0)
     171 oz.             3428) 205680 (6|0 (3 l.
     20                          ..    6
    ----                        205680 ---
    3428 pwt.                  -------- (0) Facit 60 s. or 3 l.
                                 (0)
```

Quest.

Quest. 14. A Grocer bought 4 Hogsheads of Sugar, each weighing near 6*C*. 2*qrs*. 14℔ which cost him 2*l*. 8*s*. 6*d*. *per C*. I demand the Value of the 4 Hhds, at that Rate?

First find the Weight of the 4 Hhds, which you may do by reducing the Weight of one of them into Pounds, and multiply them by 4 (the Number of Hhds) and they make 2968℔; then say, if 1 *C*. or 112℔ cost 2*l*. 8*s*. 6*d*. what will 2968℔ cost? *Facit* 64*l*. 5*s*. 3*d*. as by the Operation.

C. *qrs*. ℔
6 2 14
4
——
26
28
——
212
53
——
742℔ in 1 hhd.
4 hogsheads
——
2968 ℔ in 4 hhds.

℔ *l*. *s*. *d*. ℔
If 112 : 2 8 6 :: 2068
20 582
—— ——
48 5936
12 23744
—— 14840
102 ——
48 112) 1727376 (15423 12) (128|5 2|0 (64 *l*.
—— 112 12 12
582 —— —— ——
607 34 8
560 24 8
—— —— ——
473 102 (5) Shillings
448 96
—— ——
257 63
224 60
—— ——
336 (3) Pence
336
——
(0) *Facit* 64 *l*. 5 *s*. 3 *d*.

Quest.

Quest. 15. A Draper bought of a Merchant 8 Packs of Cloth, each containing 4 Parcels, and each Parcel 10 Pieces, and each Piece 26 Yards, and gave after the Rate of 4*l.* 16*s.* for 6 Yards, now I desire to know how much he gave for the Whole? *Answer* 6656*l.*

First find out how many Yards there were in the 8 Packs, and by the following Work you will find there are 8320 Yards; then say, if 6 Yards cost 4*l.* 16*s.* what will 8320 Yards cost, *&c.*

8 Packs
4
32 Parcels
10
320 Pieces
96
1920
640
8320 Yards

Yds. *l.* *s.* *Yds.*
6 : 4 16 :: 8320
20 96
96 49920
74880
2|0
6)798720(13312|0(6656*l.*
6 12
19 13
18 12
18 11
18 10
7 12
Facit 6656*l.* 6 12
12 (0)
12
(0)

By this time the Learner is, as I suppose, well exercised in the Practick and Theorick of the *Rule of Three Direct*; but at his Leisure he may look over the following Questions, whose Answers are given, but the Operation purposely omitted as a Touchstone for the Learner, thereby to try his Ability in what hath been deliver'd in the former Rules.

Quest. 16. If 24*l.* of Raisins cost 6*s.* 6*d.* what will 18 Frails cost, each weighing neat 3 *qrs.* 18 *l.* *Answer* 24*l.* 17*s.* 3*d.*

Quest. 17. If an Ounce of Silver be worth 5 Shillings, what is the Price of 14 Ingot, each Ingot weighing 7*l.* 5*oz.* 10*pw.* *Answer* 313*l.* 5*s.*

Quest

Quest. 18. If a Piece of Cloth cost 10*l.* 16*s.* 8*d.* I demand how many Ells *English* there are in the same, when the Ell at that Rate is worth 8*s.* 4*d.* *Answer* 26 Ells *English.*

Quest. 19. A Factor bought 84 Pieces of Stuffs, which cost him in all 537*l.* 12*s.* at 5*s.* 4*d.* *per* Yard, I demand how many Yards there were in all, and how many Ells *English* were contained in a Piece of the same? *Answer* 2016 Yards in all, and 19 $\frac{1}{5}$ Ells *English per* Piece.

Quest. 20. A Draper bought 242 Yards of Broad-cloth, which cost him in all 254*l.* 10*s.* for 86 Yards of which he gave after the Rate of 21*s.* 4*d.* *per* Yard. I demand how much he gave *per* Yard for the Remainder? *Answer* 2[illegible]*s.* 9[illegible] [illegible] *per* Yard.

Quest. 21. A Factor bought a certain Quantity of Serge and Shalloon, which together cost him 26*l.* 14*s.* 10*d.* The Quantity of Serge he bought was 48 Yards, at 4*s.* 4*d.* *per* Yard; and for every two Yards of Serge he had 5 Yards of Shalloon; I demand how many Yards of Shalloon he had, and how much the Shalloon cost him *per* Yard?

Ans. 120 Yards of Shalloon at 2*s.* 8*d.* $\frac{41}{60}$ *per* Yard?

Quest. 22. An Oilman bought three Tun of Oil, which cost him 151*l.* 14*s.* and so it chanced that it leaked out 85 Gallons; but he is minded to sell it again, so that he may be no Loser by it; I demand how he must sell it *per* Gallon? *Answer*, at 4*s* 6*d* [illegible] *per* Gallon.

Quest. 23. Bought 6 Packs of Cloth, each Pack containing 12 Cloths, which at 8*s.* 4*d.* Ell *Flemish*, cost 1080*l.* I demand how many Yards there were in each Cloth?

Answer, 27 Yards in each Cloth.

Quest. 24. A Gentleman hath 536*l.* *per Ann.* and his Expences are, one Day with another 18*s.* 10*d.* 3*qrs.* I desire to know how much he layeth up at the Year's End? *Answer* 191*l.* 3*s.* 8*d.* 1*qr.*

Quest. 25. A Gentleman expendeth daily one Day with another 27*s.* 10*d.* $\frac{1}{2}$, and at the Year's End layeth up 340*l.* I demand how much is his yearly Income? *Answer* 848*l.* 14*s.* 4*d.* $\frac{1}{2}$

Quest. 26. If I sell 14 Yards for 10*l.* 10*s.* how many Ells *Flemish* shall I sell for 283*l.* 17*s.* 6*d.* at that Rate? *Answer* 504 $\frac{4}{5}$ Ells *Flemish.*

Quest. 27. If 100*l.* in 12 Months, gain 6*l.* Interest, how much will 75*l.* gain in the same Time, and at the same Rate? *Answer* 4*l.* 10*s.*

Quest.

Quest. 28 If 100*l.* in 12 Months, gain 6*l.* Interest, how much will it gain in 7 Months at that Rate? *Answer* 3*l.* 10*s.*

Quest. 29. A certain Usurer put out 73*l.* for 12 Months, and received Principal and Interest 81*l.* I demand at what Rate *per Cent.* he received Interest? *Answer* 8*l. per Cent.*

Quest. 30. A Grocer bought 2 Chests of Sugar, the one weigh'd neat 18 *C.* 3*qrs.* 14*l.* at 2*l.* 6*s.* 8*d per C.* the other weigh'd neat 18 *C.* 1*qr.* 21*l.* at 4*d.* $\frac{1}{2}$ *per l.* which he mingled together; now I desire to know how much a *C. wt.* of this Mixture is worth? *Answ.* 2*l.* 4*s.* 2$\frac{1078}{4067}$ *qrs.*

Quest. 31. Two Men, *viz. A* and *B* departed both from one Place, the one goes *East*, and the other *West*; one travelleth 4 Miles a Day, and the other 5 Miles a Day, how far are they distant, distant the 9th Day after their Departure? *Answer* 81 Miles.

Quest. 32. *A* flying every Day 40 Miles, is pursued the fourth Day after by *B*, posting 50 Miles a Day? now the Question is, in how many Days, and after how many Miles Travel will *A* be overtaken?

Answ. B overtakes him in 32 Days, when they have travelled 600 Miles. See *More*'s Arithm. cap. 8. qu. 7.

11. The general Effect of the Rule of Three Direct, is contained in the Definition of the same, that is, to find a fourth Number in Proportion, consisting of two equal Reasons; as hath been fully shewn in all the foregoing Examples.

The second Effect is, by the Price or Value of one Thing, to find the Price and Value of many Things of like Kind.

The third Effect is, by the Price or Value of many Things, to find the Price of one; or by the Price of many Things, (the said Price being one) to find the Price of many Things of like Kind.

The 4th Effect is, by the Price or Value of many Things, to find the Price or Value of many Things of like Kind.

The fifth Effect is, thereby to reduce any Number of Moneys, Weights, or Measures, the one Sort into the other, as in the Rules of Reduction contained in the eighth Chapter foregoing. Examples of its various Effects have been already answered.

12. The Rule of Three Direct is thus proved, *viz.* multiply the first Number by the fourth, (*The Proof of the Rule of Three Direct.*) and note the Product; then multiply the second Number by the third, and if this Product is equal to the Product of the first and fourth, then the Work is rightly performed, otherwise it is erroneous.

So the first Question of this Chapter (whose Answer or fourth Number we found to be 18*s*.) is thus proved, *viz.* the first Number is 4, which multiplied by 18 (the fourth) produced 72, and the second and third Numbers are 12 and 16, which multiplied together produceth 72, equal to the Product of the first and fourth, and therefore I conclude the Work to be rightly performed.

Always observing, that if any Thing remain after you have divided the Product of the second and third Numbers by the first, such Remainder in proving the same must be added to the Product of the first and fourth Numbers, whose Sum will be equal to the Product of the second and third, the second Number being of the same Denomination with the fourth, and the first of the same Denomination with the third.

So the fourth Question of this Chapter being again repeated, *viz.* if 142lb of Tobacco cost 27*s*. what will 478lb cost at that Rate? The Answer (or fourth Number) was 40*l*. 1*s*. 10*d*. 1*qr*. $\frac{1}{14}$, which is thus proved, *viz.* bring the fourth Number into Farthings, and it makes 44294, which multiplied by the first Number 14, produceth 619488 (the second which remaineth being added thereto; then, because I reduce my fourth Number into Farthings, I reduce my second (*viz.* 27*s*.) into Farthings, and they are 1296, which multiplied by the third Number 478, their Product is 619488, equal to the Product of the first and fourth Numbers, wherefore I conclude the Operation to be true. This is an infallible Way to prove the Rule of Three Direct, and it is deduced from the 12th Section of the 9th Chapter of this Book.

And thus much for this inestimable Rule of Three Direct, the Demonstration of which may be seen in *Kersey*'s Appendix to *Wingate*'s Arithmetick, and in the 6th Chapter of *Oughtred's Clavis Mathematicæ*.

CHAP. XI.

The Single Rule of Three Inverse.

1. THE Golden Rule, or Rule of Three Inverse, is when there are three Numbers given, to find a fourth in such Proportion to the three given Numbers, so as the fourth proceeds from the second, according to the same Rate, Reason or Proportion, that the first proceeds from the third, or the Proportion is.

As the fifth Number is in Proportion to the second, so is the first to the fourth. See *Alsted Math.* l. 2. c. 14.

So if the three given Numbers were 8, 12 and 16, and it were required to find a fourth Number in an inverted Proportion to these, I say, that as 16 (the third Number) is the Double of the first Term or Number (8) so must 12, the second Number, be the Double of the fourth: so will you find the fourth Term or Number to be 6 And (as in the Rule of Three Direct) you multiply the second and third together, and divide their Product for a fourth proportional Number.

2. In the Rule of Three Inverse, you must multiply the second Term by the first, or first Term by the second, and divide the Product thereof by the first Term, so the Quotient will give you the fourth Term sought in an inverted Proportion. The same Order being observed in this Rule as in the Rule of Three Direct, for placing and disposing of the given Numbers, and after your Numbers are placed in Order, that you may know whether your Question be to be resolved by the Rule Direct or Inverse, observe the general Rule following.

3 When your Question is stated, and your Numbers orderly disposed, consider in the first Place whether the fourth Term or Number sought ought to be more or less than the second Term, which you may easily do; and if it is required to be more or greater than the second Term, then the lesser Extreme must be your Divisor; but if it requires less, then the highest Extreme must be your Divisor; in this Case the first and third Numbers are called Extremes (in respect of the second) and having found out your Divisor, you may know whether your Question belong to the Rule Direct or Inverse; for if the third Term be your Divisor, then it is Inverse, but if the first Term be your Divisor, then it is a Direct Rule: As in the following Questions.

Quest. 1. If 8 Labourers can do a certain Piece of Work in 12 Days, in how many Days will 16 Labourers do the same? *Answer*, in 6 Days.

Having placed the Numbers according to the 6th Rule of the 10th Chapter, I consider, that if 8 Men can finish the Work in 12 Days, 16 Men will do it in lesser (or fewer Days) than 12, therefore the bigger Extreme must be the Divisor, which is 16, and therefore it is the Rule of Three Inverse; wherefore I multiply the first and second Numbers together, *viz.* 8 by 12, and their Product is 96, which di-

Lab.	*Days*	*Lab.*
8	12	16
	8	
	16) 96 (6 Days	
	96	
	(0)	

Facit 6 Days.

vided by 16, quotes 6 Days for the Anſwer; and in ſo many Days will 16 Labourers perform a Piece of Work, when 8 Men can do it in 12 Days.

Queſt. 2 If, when the Meaſure, *viz.* (a Peck) of Wheat coſt 2*s.* the Penny Loaf weighed (according to the Standard, Statute or Law of *England*) 8 Ounces, I demand how much it will weigh when the Peck is worth 1*s.* 6*d.* according to the ſame Rate or Proportion? *Anſwer* 10*oz.* 13*pwt.* 8*gr.*

Having placed and reduced the given Numbers according to the 6th and 9th Rules of the 10th Chapter, I conſider, that at 1*s* 6*d. per* Peck, the Penny Loaf will weigh more than at 2*s*, *per* Peck; for as the Price decreaſeth, the Weight increaſeth; and as the Price increaſeth, ſo the Weight diminiſhes; wherefore, becauſe the firſt Term requires more than the ſecond, the leſſer Extreme muſt be the Diviſor, *viz.* 1*s.* 6*d.* or 18*d.* and having finiſhed the Work, I find the Anſwer to be 10*oz.* 13*pwt.* 8*gr.* and ſo much will the Penny Loaf weigh when the Peck of Wheat is worth 1*s.* 6*d.* according to the given Rate of 8 Ounces when the Peck is worth 2*s.* The Work is plain in the following Operation.

```
       d.    oz.   gr.
    If 24    8     18
        8
    ------oz. pwt. gr.
18) 192 (10  13    8 Anſ.
    18
    --
     12
     20
    ---pwt.
    240 (13
    18
    ---
     60
     54
    ---
     (6)
     24
    ---
    144 (8 gr.
    144
    ---
     (0)
```

Queſt.

Quest. 3. How many Pieces of Money or Merchandize, at 20*s.* *per* Piece, are to be given or received for 240 Pieces, the Value or Price of every Piece being 12 Shillings? *Ans.* 144 Pieces. For if 12*s.* required 240 Pieces, then 20*s.* will require less; therefore the bigger Extreme must be the Divisor, which is the third Number, *&c.* See the Work as in the Margent.

s.	*pcs.*	*s.*
If 12	240	20
	12	
	480	
	240	
2|0)	288|0	(144 *pcs.* at 20*s.* *per* pc.
	2	
	8	
	8	
	8	
	8	
	(0)	

Quest. 4. How many Yards of 3 Quarters broad are required to double or be equal in Measure to 30 Yards that are 5 Quarters broad? *Answer* 50 Yards. For say, if 5 Quarters will require 30 Yards long, what Length will 3 Quarters broad require? Here I consider that 3 Quarters broad will require more Yards than 30; for the narrower the Cloth is, the more in Length will go to make equal Measure with a broader Piece.

qrs.	*long*	*qrs.*
5	30	3
	5	
3)	250 (50 *Yards*	
	15	
	(0)	

Quest. 5. At the Request of a Friend I lent him 200*l.* for 12 Months, promising to do me the like Courtesy at my Necessity; but when I came to request it of him, he could let me have but 150*l.* now I desire to know how long I may keep this Money to make plenary Satisfaction for my former Kindness to my Friend? *Ans.* 16 Months I say, if 200*l.* require 12 Months, what will 150*l.* require? 150*l.* will require more Time than 12 Months, therefore the lesser Extreme (*viz.* 150) must be the Divisor; multiply and divide, and you will find the fourth inverted Proportional to be 16, and so many Months I ought to keep the 150*l.* for Satisfaction.

Quest. 6. If for 24*s.* I have 1200℔ Weight carried 36 Miles, how many Miles shall 1800℔ be carried for the same Money? *Answer* 24 Miles.

Quest. 7. If for 24*s.* I have 1200℔ Weight carried 36 Miles, how many ℔ Weight shall I have carried 24 Miles for the same Money? *Answer* 1800℔ Weight.

Quest. 8. If 100 Workmen in 12 Days finish a Piece of Work or Service, how many Workmen are sufficient to do the same in 3 Days? *Answer* 400 Workmen.

Quest. 9 A Colonel is besieged in a Town, in which are 1000 Soldiers, with Provision of Victuals only for 3 Months; the Question is, how many of his Soldiers must he dismiss, that his Victuals may last the remaining Soldiers 6 Months? *Answer* 500 he must keep, and dismiss as many.

Quest. 10. If 20*l.* worth of Wine is sufficient for the Ordinary of 100 Men, when the Tun is sold for 30*l.* how many Men will the same 20*l.* worth suffice, when the Tun is worth 24*l.*? *Answer* 125 Men.

Quest. 11. How much Plush is sufficient for the Cloak which hath in it 4 Yards of 7 Quarters wide, when the Plush is but 3 Quarters wide? *Ans.* 9 $\frac{1}{3}$ Yards of Plush.

Quest. 12. How many Yards of Canvas, that is Ell wide, will be sufficient to line 20 Yards of Say that is 3 Quarters wide? *Answer* 12 Yards.

Quest. 13. How many Yards of Matting that is 2 Foot wide, will cover a Floor that is 24 Foot long and 20 Foot broad? *Answer* 240 Foot.

Quest. 14. A Regiment of Soldiers consisteth of 1000, and to have new Coats, and each Coat to contain two Yards two Quarters of Cloth that is 5 Quarters wide, and they are to be lined with Shalloon that is 3 Quarters wide, I demand how many Yards of Shalloon will line them? *Answer* 16666 $\frac{2}{3}$ Quarters, or 4166 $\frac{2}{3}$ Yards.

Quest. 15. A Messenger makes a Journey in 24 Days, when the Day is 24 Hours long; I desire to know in how many Days he will go the same, when the Day is 16 Hours long? *Answer* in 18 Days.

Quest. 16. I borrowed of my Friend 64*l.* for 8 Months, and he hath Occasion another Time to borrow of me for 12 months I desire to know how much I must lend to make good his former Kindness to me? *Answer* 42*l.* 13*s.* 4*d.*

4. The general Effect of the Rule of Three Inverse, is contained in the Definition of the same, that is, to find a fourth Term in a reciprocal Proportion inverted to the Proportion given.

The second Effect is, by two Pieces, or Value of two several Pieces of money and merchandize known, to find how many Pieces of the one Price is to be given for so many of the other; and so to reduce and exchange one Sort of money or merchandize into another. Or else to find the Price unknown of any Piece given to exchange in reciprocal Proportion.

The

The third Effect is, by two different Prices of a Measure of Wheat bought or sold, and the Weight of a Loaf of Bread, made answerable to one of the Prices of the Measure given, to find out the Weight of the same Loaf answerable to the other Price of the said Measure given.

Or else, by the two several Weights of the same priced Loaf, and the Price of the Measure of Wheat answerable to one of those Weights given, to find out the other Price of the Measure answerable to the other Weight of the same Loaf.

The fourth Effect is, by two Lengths and one Breadth of two rectangular Planes known, to find out another Breadth unknown. Or, by two Breadths and one Length given, to find out another Length unknown in an inverted Proportion.

The fifth Effect is, by double Time and a capital Sum of Money borrowed or lent, to find out another capital Sum answerable to one of the given Times; or otherwise, by two capital Sums, and a Time answerable to one of them given, to find out a Time answerable to the other capital Sum in reciprocal Reason.

The sixth Effect is, by two different Weights of Carriage, and the Distance of the Place in Miles or Leagues given, to find another Distance in Miles answerable to the same Price of Payment. Or otherwise, by two Distances in Miles, and the Weight answerable to one of the Distances (being carried for a certain Price) to find out the Weight answerable to the other Distance for the same Price.

The seventh Effect is, by double Workmen, and the Time answerable to one of the Numbers of Workmen given, to find out the Time answerable to the other Number of Workmen, in the Performance of any Work or Service. Or contrarywise, by double Time, and the Workmen answerable to one of those Times given, to find out the Number of Workmen answerable to the other Time, in the Performance of any Work or Service.

Also by a double Price of Provision, and the Number of Men or other Creatures nourished for a certain Time, answerable to one of the Prices of Provision given, to find out another Number of Men or other Creatures answerable to the other Price of the Provision for the same Time. Or contrarywise, by two Numbers of Men or other Creatures nourished, and one Price of Provision answerable to one of the Numbers of Creatures given, to find out the other Price of the same Provision answerable to the other Number of Creatures, both being supposed to be nourished for the same, *&c.*

To prove the Operation of the Rule of Three Inverse, multiply the 3d and 4th Terms together, and note their Product, and multiply the 1st and 2d together, and if their Product is equal to the Product of the 3d and 4th, then is the Work truly wrought, but if it falleth out otherwise, then it is erroneous.

As in the first Question of this Chapter, 16 (the third Number) being multiplied by 6 (the fourth Number) the Product is 96, and the Product of 8 (the first Number) multiplied by 12 (the second Number) is 96, equal to the first Product, which proves the Work to be right.

And note, That if in Division any Thing remain, such Remainder must be added to the Product of the third and fourth Terms, and if the Sum be equal to the Product of the first and second) the homogeneal Terms being of one Denomination, the Work is right.

CHAP. XII.

The Double Rule of Three Direct.

WE have already delivered the Rule of single Proportion, and we come now to lay down the Rules of Plural Proportion.

1. Plural Proportion is, when more Operations in the Rule of Three than one are required before a Solution can be given to the Question propounded. Therefore in Questions that require Plurality in Proportion, there are always given more than three Numbers.

2. When there are given five Numbers, and a sixth is required in Proportion thereunto, then the sixth Proportion is said to be found out by the Double Rule of Three, as in the Question following, *viz.*

If 100*l.* in 12 Months gain 6*l.* Interest, how much will 75*l.* gain in 9 Months?

3. Questions in the Double Rule of Three may be resolved either by two single Rules of Three, or by one single Rule of Three compounded of the five given Numbers.

4. The Double Rule of Three is either Direct or else Inverse.

5. The Double Rule of Three Direct is, when unto 5 given Numbers, a 6th Proportional may be found out by two single Rules of Three Direct.

6 The 5 given Numbers in the Double Rule of Three Direct consisteth of two Parts, *viz.* 1 A Supposition, and 2dly, of a Demand: The Supposition is contained in the three first of the five given Numbers, and the Demand lies

in

in the two last, as in the Example of the second Rule of this Chapter, *viz.* If 100*l* in 12 Months gain 6*l*. Interest, what will 75*l*. gain in 9 Months? Here the Supposition is expressed in 100, 12, and 6; for it is said, if 100*l*. in 12 Months gain 6*l*. Interest · And the Demand lieth in 75 and 9; for it is demanded, How much 75*l*. will gain in 9 Months.

7. When your Question is stated, the next Thing will be to dispose of the given Numbers in due Order and Place, as a preparative for Resolution; which that you may do, first, Observe which of the given Numbers in the Supposition is of the same Denomination with the Number required, for that must be the 2d Number (in the first Operation) of the Single Rule of Three, and one of the other Numbers in the Supposition (it matters not which) must be the first Number, and that Number in the Demand, which is of the same Denomination with the first, must be the third Number; which three Numbers being thus placed, will make one perfect Question in the Single Rule of Three, as in the forementioned Example; first, I consider, that the Number required in the Question is in the Interest or Gain of 75*l*. therefore that Number in the Supposition which hath the same Name, *viz.* 6*l*. which is the Interest or Gain of 100*l*. must be the second Number in the first Operation, and either 100 or 12 (it matters not which) must be the first Number, but I will take 100; and then for the third Number, I put that Number in the Demand which hath the same Denomination with 100, which is 75, for they both signify Pounds principal, and then the Numbers will stand as you see in the Margent.

100 : 6 :: 75

But if I had for the first Number put the other Number in the Supposition, *viz.* 12, which signifies 12 Months, then the third Number must have been 9, which is the Number in the Demand which hath the same Denomination with the first, *viz.* 9 Months, and they will stand as in the Margent.

12 6 9

There yet remains two Numbers to be disposed of, and those are one in the Supposition, and another in the Demand; that which is of the Supposition, I place under the first of the three Numbers; and the other, which is the Demand, I place under the third Number; and then two of the Terms in the Supposition will stand (one over the other) in the first Place, and the two Terms in the Demand will stand (one over the other) in the third Place, as in the Margent.

100	6	75
12		9

Or this,

12	6	9
100		75

 8. Having

1. Having disposed or ordered the given Numbers according to the last Rule, we may proceed to a Resolution: And first I work with the 3 uppermost Numbers, which, according to the first Disposition are 100 : 6 :: and 75; which is as much as to say, if 100*l.* requires 6*l.* Interest, how much will 75*l.* require? Which, by the third Rule of the 11th Chapter, I find to be Direct, and by the 7th and 8th Rules of the 10th Chapter, I find the 4th proportional Number to be 4*l.* 10*s.* so that by the foregoing single Question I have discovered how much Interest 75*l.* will gain in 12 Months; the Operation whereof followeth on the left Hand under the Letter A: And having discovered how much it will gain in 12 Months, we may by another Question easily discover how much it will gain in 9 Months; for this 4th Number (thus found) I put in the Middle between the two lowest Numbers of the 5, after they are placed according to the 7th Rule of this Chapter, and then it will be a second Number, in another Question in the Rule of Three. The Numbers being

M.		l.	s.		M.
12	:	4	10	::	9

the first and third Numbers being of one Denomination, *viz.* both Months, and may be thus expressed; if 12 Months require 4*l.* 10*s.* Interest, what will 9 Months require? And by the third Rule of the 11th Chapter, I find it to be the Direct Rule, and by working according to the Directions laid down in the 7th, 8th and 9th Rules of the 10th Chapter, I find the fourth proportional Number to the last single Question to be 3*l.* 7*s.* 6*d.* which is the sixth proportional Number to the five given Numbers, and is the Answer to the general Question. The Work of the last single Question is expressed on the right Side of the Page, under the Letter B, as followeth.

A	B
100	--6—75
12	9
l. *l.* *l.*	Then say.
If 100 6 75	*M.* *l.* *s.* *M.*
75	If 12 4 10 9
	20
30	90
42	12
	180
1'00) 4'50(4 10	90
	1080 Pence
4	9
	12 20 *l.* *s.* *d.*
Rem. (50)	12)9720(810(67 (3 7 6
Mult. 20	
	96 72
1|00) 10|00 (10 *s.*	7 *s.*
	12 90
l. *s.*	12 84
Facit 4 10	(0) (6) *d.*
	Facit 3*l.* 7*s.* 6*d.*

So that by the foregoing Operation I conclude, that if, 100*l.* in 12 Months, gain 6*l.* Interest, 75*l.* will gain 3*l.* 7*s.* 6*d.* in 9 Months, after the same Rate. The Answer would have been the same if the 5 given Numbers had been ordered according to the second Method, *viz.* as you see in the Margent.

12	6	9
100		75

For first, I say, if 12 Months gain 6*l.* what will 9 Months gain? This Question I find to be Direct, by the 3d Rule of the 21th Chapter, and by the 7th and 8th Rules of the 10th Chapter, I find the fourth proportional Number to these three to be 4*l.* 10*s.*

Thus have I found out what is the Interest of 100*l.* for 6 Months, and am now to find the Interest of 75*l.* for 9 Months; to effect which, I make this fourth Number (found as before) to be my second Number in the next Question, I say, if 100*l.* require 4*l.* 10*s.* what will 75*l.* require? This Question I find (by the said 3d Rule of the 11th Chapter) to be Direct, and by the said 7th, 8th, and 9th Rules of the 10th Chapter, I find the Answer to be as before, *viz.* 3*l.* 7*s.* 6*d.*

The Operation of this Rule in the following Questions, are purposely omitted, to try the Learner's Capacity.

Quest.

Queſt. 2. A ſecond Example in this Rule may be as followeth, *viz.* A Carrier receiving 42*s.* for the Carriage of 300 Weight 150 Miles, I demand how much he ought to receive for the Carriage of 7*C.* 3*qrs.* 4lb 50 Miles at that Rate? *Anſwer* 36*s.* 9*d.*

Queſt, 3. A Regiment of 936 Soldiers eat up 351 Quarters of Wheat in 168 Days, I demand how many Quarters of Wheat 11232 Soldiers will eat in 56 Days at that Rate? *Anſwer* 1404 Quarters.

Queſt. 4. If 40 Acres of Graſs be mowed by 8 Men in 7 Days, how many Acres ſhall be mowed by 24 Men in 28 Days? *Anſwer* 480 Acres.

Queſt. 5. If 48 Buſhels of Corn (or other Seed) yield 576 Buſhels in a Year, how much will 240 Buſhels yield in 6 Years at that Rate? That is to ſay, if there were ſowed 240 Buſhels every one of the 6 Years? *Anſwer* 17280 Buſhels.

Queſt. 6. If 40 Shillings be the Wages of 8 Men for 5 Days, what will be the Wages of 32 Men for 24 Days? *Anſwer* 768 Shillings, or 38*l.* 8*s.*

Queſt. 7. If 14 Horſes eat 46 Buſhels of Provender in 16 Days, how many Buſhels will 20 Horſes eat in 24 Days? *Anſwer* 120 Buſhels.

Queſt. 8. If 8 Cannons in one Day ſpend 48 Barrels of Powder, I demand how many Barrels 24 Cannons will ſpend in 22 Days at that Rate? *Anſwer* 1728 Barrels

Queſt. 9. If in a Family conſiſting of 7 Perſons, there are drank out 2 Kilderkins of Beer in 12 Days, how many Kilderkins will there be drank out in 8 Days, by another Family conſiſting of 14 Perſons? *Anſwer* 48 Gallons, or 2 Kilderkins and 12 Gallons.

Queſt. 10. An Uſurer put 75*l.* out, to receive Intereſt for the ſame, and when it had continued 9 Months, he received for Principal and Intereſt 78*l.* 7*s.* 6*d.* I demand at what Rate *per cent per annum* he received Intereſt? *Anſwer* 6*l. per cent per annum*

CHAP. XIII.

The Double Rule of Three Inverſe.

THE Double Rule of Three Inverſe is, when a Queſtion in the Double Rule of Three is reſolved by two ſingle Rules of Three, and one of thoſe ſingle Rules falls out to be Inverſe, or requires a fourth Number in Proportion reciprocal (for both Queſtions are never Inverſe.)

2. In

2. In all Questions of the Double Rule of Three (as well Inverse as Direct) you are, in the disposing of the 5 given Numbers, to observe the 7th Rule of the 12th Chapter, and in resolving of it by two single Rules, observe to make choice of your Numbers for the first and second single Questions, according to the Directions given in the 8th Rule of the same Chapter, and in the Example following, *viz.*

Quest. 1. If 100*l.* Principal in 12 Months gain 6*l.* Interest, what Principal will gain 3*l.* 7*s.* 6*d.* in 9 Months?

This Question is an Inversion of the first Question of the 12th Chapter, and may serve for a Proof thereof

In order to a Resolution, I dispose of the 5 given Numbers, according to the 7th Rule of the last Chapter; and being so disposed, they will stand as follow.

12	100	9		
6		3	7	6

Or thus,

l.		*l.*	*s.*	*d.*
6	100	3	7	6
12		9		

Here observe, That according to the 8th Rule of the 12th Chapter, the first Question (if you take it from the 5 Numbers, as they are ordered or placed first) will be, if 12 Months require 100*l.* Principal, what will 9 Months require to make the same Interest? This (according to the 3d Rule of the 11th Chapter) is Inverse, and the Answer will be found (by the 2d Rule of the 11th Chapter) to be 133*l.* 6*s.* 8*d.* The second Question then will be, if 6*l.* Interest require 133*l.* 6*s.* 8*d.* Principal; how much Principal will 3*l.* 7*s.* 6*d.* require? This is a direct Rule, and the Answer in a direct Proportion, is 75*l.* See the Work

First I say,

```
M.   l.   M.
12   100  9
     12
   ------
9) 1200 (133  6  8
     ..
9         l.   s.  d.
-- Facit 133   6   8
  30
  27
  ----
  30
  27
  ----
  (3)
  20
  ----
9) 60 (6 s.
   54
  ----
  (6)
  12
  ----
9) 72 (8 d.
   72
  ----
  (0)
```

Then

Then I say,

```
     l.      l.  s.  d.       l.  s.  d.
If   6   :  133  6   8   ::   3   7   6
   240       20                20
  1440 d.   266                67
             12                12
           5340               140
          2666                67
          32000               810 d.
            810
          32000
         256
         ------------ 24|0
144|0)2592000|0(1800|0(75 l.

    144      168
    1152      120
    1152      120
     (0)      (0)
```

So that by the foregoing Work I find that if 6*l.* Interest be gained by 100*l.* in 12 Months, 3*l.* 7*s.* 6*d.* will be gained by 75*l.* in 9 Months.

But if the Resolution had been found out by the Numbers as they are ranked in the second Place, then the second Question in the single Rule would have been Inverse, and the first Question Direct, and the Conclusion the same with the first Method, *viz.* 75*l.*

Quest. 2. If a Regiment consisting of 936 Soldiers can eat up 351 Quarters of Wheat in 168 Days, how many Soldiers will eat up 1400 Quarters in 56 Days, at that Rate? *Answer* 11200 Soldiers.

Quest. 3. If 12 Students in 8 Weeks spend 48*l.* I demand how many Students will spend 288*l.* in 18 Weeks? *Answer* 32 Students.

Quest. 4. If 48 lb serve 12 Students 8 Weeks, how many Weeks will 288 lb serve 4 Students? *Ans.* 144 Weeks.

Quest. 5. If when a Bushel of Wheat cost 3*s.* 4*d.* the Penny Loaf weigheth 12 Ounces, I demand the Weight of the Loaf worth 9*d.* when the Bushel cost 10*s.* *Answer* 36 oz.

Quest. 6. If 48 Pioneers in 12 Days cast a Trench 24 Yards long, how many Pioneers will cast a Trench 168 Yards long in 16 Days? *Answer* 252 Pioneers.

Quest. 7. If 12C.wt being carried 100 Miles, cost 5*l.* 11*s.* I desire to know how many C.wt. may be carried 150 Miles for 12*l.* 12*s.* at that Rate? *Ans.* 18C.

Quest.

Quest. 8. If when Wine is worth 30*l.* *per* Ton, 20*l.* worth is sufficient for the Ordinary of 100 Men, how many Men will 4*l.* worth suffice when it is worth 24*l.* *per* Ton? *Answer* 25 Men.

Quest. 9. If 6 Men in 24 Days mow 72 Acres, in how many Days will 8 Men mow 24 Acres? *Ans.* in 6 Days.

Quest. 10. If when the Ton of Wine is worth 30*l.* 100 Men will be satisfied with 20*l.* worth, I desire to know what the Ton is worth when 4*l.* worth will satisfy 25 Men at the same Rate? *Answer* 24*l.* *per* Ton.

CHAP. XIV.

The Rule of Three composed of five Numbers.

THE Rule of Three composed is, when Questions (wherein there are five Numbers given, to find a sixth in proportion thereunto) are resolved by one single Rule of Three composed of the five given Numbers.

2. When Questions may be performed by the Double Rule of Three Direct, and it is required to resolve them by the Rule of Three composed; first order or rank your Numbers according to the 7th Rule of the 12th Chap. then

The Rule is,

Multiply the Terms or Numbers (that stand one over the other in the first Place) the one by the other, and make their Product the first Term in the Rule of Three Direct; then multiply the Terms that stand one over the other in the third Place, and place their Product for the third Term in the Rule of Three Direct, and put the middle Term of the 7 uppermost for a second Term; then having found a fourth Proportional direct to these three, this fourth Proportional so found shall be the Answer required.

So the first Question of the 13th Chapter being proposed, *viz.* if 100*l.* in 12 Months gain 6*l.* Interest, what will 75*l.* gain in 9 Months?

The Numbers being ranked or placed as is there directed and done, then I multiply the two first Terms 100 and 12 the one by the other, and their Product is 1200 for the first Term; then I multiply the last two Terms 75 and 9 together, and their Product is 675 for the third Term: Then I say, as 1200 is to 6, so is 675 to the Answer, which by the Rule of Three Direct will be found to be 3*l.* 7*s.* 6*d.* as was before found.

3. But if the Question be to be answer'd by the Double Rule of Three Inverse, then (having placed the 5 given Terms as before) multiply the lowermost Term of the first

Place

Place by the uppermost Term of the third Place, and put the Product for the first Term; then multiply the uppermost Term of the first Place by the lowermost Term of the third Place, and put the Product for the third Term, and the second Term of the three highest Numbers for the middle Term of those two; then if the Inverse Proportion is found in the uppermost three Numbers, the fourth Proportional direct to these three shall be the Answer. So the first Question in the 13th Chapter being stated, *viz.* if 100*l.* Principal in 12 Months gain 6*l.* Interest, what Principal will gain 3*l.* 7*s.* 6*d.* in 9 Months? State the Numbers as there directed in the first Order, *viz.*

M.	*l.*	*M.*
12	100	9
l.		*l. s. d.*
6		3 7 6

Then reduce the 6*l.* and 3*l.* 7*s.* 6*d.* into Pence, the 6*l.* is 1440*d.* and 3*l.* 7*s.* 6*d.* is 810*d.* then multiply 1440 by 9, the Product is 12960 for the first Term in the Rule of Three Direct, and multiply 810 by 12, the Product is 9720 for the third Term; then I say, as 12960 is to 100*l*, so is 9720 to the Answer, *viz.* 75*l.* as before. But if the Terms had been placed after the second Order, *viz.*

l.		*l.*		*l.*	*s.*	*d.*
6	:	100	: :	3	7	6
M.				*M.*		
12				9		

Then the Inverse Proportion is found in the lowest Numbers, and having composed the Numbers for a single Rule of Three, as in the second Rule foregoing; then the Answer must be found by a single Rule of Three Inverse; for here it falls out to multiply 810 by 12 for the first Number, 1440 by 9 for the third Number; and then you must say, as 9720 is to 100*l.* so is 12960 to the Answer, which by Inverse Proportion will be found to be 75*l.* as before.

The Question in the 12th and 13th Chapters may serve for thy farther Experience.

CHAP. XV.

Single Fellowship.

FEllowship is that Rule of Plural Proportion whereby we ballance Accompts depending between diverse Persons, having put together a general Stock, so that they may every Man have his proportional Part of Gain, or sustain his proportional Part of Loss.

2. The

2. The Rule of Fellowship is either single, or it is double.

3. The single Rule is, when the Stocks propounded are single Numbers, without any respect or relation to Time, each Partner continuing his Money in Stock for the same Time.

4. In the single Rule of Fellowship the Proportion is, as the whole Stock of all the Partners is in proportion to the total Gain or Loss, so is each Man's particular Share in the Stock, to his particular Share in the Gain or Loss. Therefore take the Total of all the Stocks for the first Term in the Rule of Three, and the whole Gain or Loss for the second Term, and the particular Stock of any one of the Partners for the third Term, then multiply and divide according to the seventh Rule of the 9th Chapter, and the fourth proportional Number is the particular Loss or Gain of him whose Stock you made your second Number, wherefore repeat the Rule of Three as often as there are particular Stocks or Partners in the Question, and the fourth Terms produced upon the several Operations are the respective Gain or Loss of those particular Stocks given, as in the Example following.

Quest. 1. Two Persons, *viz. A* and *B*, bought a Tun of Wine for 20*l.* of which *A* paid 12*l.* and *B* paid 8*l.* and they gained in the Sale thereof 5*l* now I demand each Man's Share in the Gain, according to his Stock?

First, I find the Sum of all their Stocks, by adding them together, *viz.* 12*l.* and 8*l.* which are 20*l.* then according to this Rule, I say first, if 20*l.* (the Sum of their Stocks) require 5*l.* the total Gain, how much will 12*l.* (the Stock of *A*) require? Multiply and divide by the 7th Rule of the 9th Chapter, and the Answer is 3*l.* for the Share of *A* in the Gain; then again I say, if 20*l.* require 5*l.* what will 8*l.* require? The Answer is 2*l.* which is the Gain of *B*; so I conclude the Share of *A* in the Gain is 3*l.* and the Share of *B* in the Gain is 2*l.* which in all is 5*l.*

$$\begin{array}{r} 12 \\ 8 \\ \hline 20\,l. \end{array}$$

$$\begin{array}{lcccc} & l. & & l. & & l. \\ \text{If} & 20 & : & 5 & :: & 12 \end{array}$$

$$\begin{array}{r} 12 \\ \hline 20)\ 60\ (3\,l. \\ 60 \\ \hline (0) \end{array}$$

$$\begin{array}{lcccc} & l. & & l. & & l. \\ \text{If} & 20 & : & 5 & :: & 8 \end{array}$$

$$\begin{array}{r} 8 \\ \hline 20)\ 40\ (2\,l. \end{array}$$

Quest.

Quest. 2. Three Merchants, *viz.* *A*, *B* and *C*, enter upon a joint Adventure, *A* put into the common Stock 78*l.* *B* put in 117*l.* and *C* put in 234*l.* and they find (when they make up their Accompts) that they have gained in all 264*l.* now I desire to know each Man's particular Share in the Gain?

First, I add their particular Stocks together, and their Sum is 429*l.* then say, if 429*l* gain 264*l.* what will 78*l.* gain? And what will 117*l.* and what will 234*l.* (the Stocks of *A*, *B* and *C*) gain? Work by three several Rules of Three, and you will find that

	78
	117
	234
Sum	429

$$\text{The Gain of} \left\{\begin{matrix} A \\ B \\ C \end{matrix}\right\} \text{is} \left\{\begin{matrix} 48 \\ 72 \\ 144 \end{matrix}\right.$$

Sum 264

Quest. 3. Four Partners, *viz.* *A*, *B*, *C* and *D*, amongst them built a Ship, which cost 1730*l.* of which *A* paid 346*l.* *B* 519*l.* *C* 692*l.* and *D* 173*l.* and her Freight for a certain Voyage is 370*l.* which is due to the Owners or Builders; I demand each Man's Share therein, according to his Charge in building her?

Answer,	
A	74
B	111
C	148
D	37
	370

Quest. 4. *A*, *B* and *C* enter into Partnership for a certain Time, *A* put into a common Stock 364*l.* *B* put in 482*l.* *C* put in 500*l.* and they gained 867*l.* now I demand each Man's Share in the Gain, proportionable to his Stock?

Answer,	*l.*	*s.*	*d.*	
A	234	9	3	$\frac{354}{1346}$
B	310	9	5	$\frac{62}{1346}$
C	222	0	3	$\frac{930}{1346}$
Sum	867	0	0	

5. To prove the single Rule of Fellowship, add each Man's particular Gain or Loss together, (*The Proof of the Rule of Single Fellowship*) and if the total Sum is equal to the general Gain or Loss, then is the Work rightly performed, but otherwise it is erroneous. *Example.* In the first Question of this Chapter, the Answer was, That the Gain of *A* was 3*l.* and the Gain of *B* 2*l.* which added together makes 5*l* equal to the total Gain given.

If in finding out the particular Shares of the several Partners, any Thing remain after Division is ended, such Remainders

Remainders must be added together (they being all Fractions of the same Denomination) and their Sum divided by the common Divisor in each Question, *viz.* the total Stock, and the Quotient added to the particular Gains; and then if the total Sum is equal to the total Gain, the Work is right, otherwise not.

As in the 4th Question, the Remainders were 354, 62 and 930, which added together make 1346, which divided by 1346 (the Sum of their Stocks) the Quotient is 1*d.* which I add to the Pence, *&c.* and the Sum of their Share is 897*l.* equal to the total Gain, wherefore I conclude the Work is right.

CAAP. XVI.

Double Fellowship.

DOuble Fellowship is, when several Persons enter into Partnership for unequal Time; that is, when every Man's particular Stock hath relation to a particular Time.

2. In the Double Rule of Fellowship, multiply each particular Stock by its respective Time, and having added the several Products together, make their Sum the first Number (or Term) in the *Rule of Three,* and the total Gain or Loss the second Number, and the Product of any one's particular Stock by his Time the third Term, and the fourth Number in proportion thereunto it his particular Gain or Loss, whose Product of Stock and Time is your third Number.

Then repeat (as in *Single Fellowship*) the *Rule of Three,* as often as there are Products (or Partners) and the four Terms thereby invented, are the Numbers required.

Example.

Quest 1. *A* and *B* enter Partnership; *A* put in 40*l.* for 6 Months, *B* put in 75*l.* for 4 Months, and they gained 70*l.* now I demand each Man's Share in the Gain, proportional to his Stock and Time? *Answer, A* 20*l.* *B* 50*l.*

To resolve this Question, I first multiply the Stock of *A*, (*viz.* 40*l.*) by its Time (3 Months) and the Product is 120; then I multiply the Stock of *B* by its Time, *viz.* 75*l.* by 4, and it produceth 300, which I add to the Product of *A*, his Stock and Time, and the Sum is 420. Then by the Rule of Three Direct I say, as 420 (the Sum of the Product) is to 70, (the total Gain) so is 120 (the Product of *A*, his Stock and Time) to 20*l.* (the Share of *A* in the Gains.) Then I say again, as 420 is to 70, so is

l.	*l.*
40	75
3	4
A 120	*B* 300
	120
	Sum 420

is 300 (the Product of *B* his Stock and Time) to 50*l.* (the Share of *B* in the Gains :) And that each is to have for his Share.

Quest. 2. *A*, *B* and *C* make a Stock for 12 Months, *A* put in at first 364*l.* and 4 Months after that he put in 40*l.* *B* put in at first 408*l.* and at the End of the 7 Months he took out 86*l.* *C* put in at first 148*l.* and 3 Months after he put in 86*l.* more, and 5 Months after that he put in 100*l.* more, and at the End of 12 Months their Gain is found to be 1436*l.* I desire to know each Man's Share in the Gains, according to his Stock and Time?

First, I consider that the whole Time of their Partnership is 12 Months: Then I proceed to find out the several Products, or Stock and Time, as followeth:

A had at first 364*l.* for 4 Months, wherefore that Product is — — - - -	1456
Then he put in 40*l.* which with the first Sum makes 404*l.* which continued the Remainder of the Times, *viz.* 8 Months, and that Product is	3233
The Sum of the Products of the Stock and Time of *A* is — — —	4688
B had 468*l.* in 7 Months, whose Product is	2856
And then took out 86*l.* therefore he left in Stock 322*l.* which continued the rest of the Time, *viz.* 5 Months, whose Product is — —	1610
The Sum of the Products of the Stock and Time of *B* is — — — —	4466
C put in 148*l.* for 3 Months, whose Product being multiplied by 3, is — —	444
Then he put in 86*l.* which added to the first, (*viz.* 148*l.*) makes 234*l.* which lay in Stock 5 Months, and their Product is — —	1170
Then he put in 100*l.* more, so then he had in Stock 334*l.* which continued the Remainder of the Time, 4 Months, which multiplied together, produces — — — —	1336
The Sum of the Product of the Money and Time of *C* is — — —	2950
B — — — —	4466
A — — — —	4688
The total Sum of all the Products is —	12104

Then I say, as 12104 is to 1426 (the total Gain) so is 4688 to the Share of *A* in the total Gain, *&c.* go on as in the foregoing Examples, and you will find their Shares in the Gain to be as followeth, *viz.*

Answer,

Anſwer,

The Share of	A	is	556	03	6	$\frac{6102}{12104}$
	B		529	16	9	$\frac{5456}{12104}$
	C		349	19	8	$\frac{416}{12104}$
			1436	00	0	

Queſt. 3. Three Graſiers, *A*, *B* and *C*, take a Piee of Ground for 46*l*. 10*s*. in which *A* put 12 Oxen for 8 months, *B* put in 16 Oxen for 5 months, and *C* put 18 Oxen for 4 months; now the Queſtion is, what each Man ſhall pay of the 46*l*. 10*s*. for his Share in that Charge?

Anſwer,

		l.	*s*.
A	ſhall pay	18	00
B		15	00
C		13	10
		46	10

3. The Proof of this Rule is the ſame with that of Single Fellowſhip, laid down in the 5th Rule of the 15th Chapter; and note, that

If a Loſs be ſuſtained inſtead of a Gain among Partners, every man's Share to be born in the Loſs, is to be found after the ſame method as their Gain, whether their Stocks be for equal or unequal Time.

CHAP. XVII.

Alligation Medial.

1. THE Rule of Alligation is that Rule in plural Proportion, by which we reſolve Queſtions wherein is a Compoſition or Mixture of diverſe Simples, as alſo it is uſeful in Compoſition of medicines, both for Quantity, Quality or Price: And its Species are two, *viz.* medial and Alternate.

2. Alligation Medial is, when having the ſeveral Quantities and Prices of ſeveral Simples propounded, we diſcover the mean Price or Rate of any Quantity of the mixture compounded of thoſe Simples, and the Proportion is,

As the Sum of the Simples to be mingled is to the total Value of all the Simples, ſo is any Part or Quantity of the Compoſition or mixture to its mean Rate or Price.

Queſt. 1. A Farmer mingled 20 Buſhels of Wheat, at 5*s*. *per* Buſhel, and 36 Buſhels of Rye at 3*s*. *per* Buſhel, with 40 Buſhels of Barley at 2*s*. *per* Buſhel; now I deſire to know what one Buſhel of that mixture is worth?

To reſolve this Queſtion, add together the given Quantities and their Value, which is 96 Buſhels, whoſe total Value is 14*l*. 8*s*. as appeareth by the Work following; for

Buſhels

Bushels				*l*	*s.*
20 of Wheat,	at 5*s.* *per* Bushel,	is		5	0
36 of Rye,	at 3*s.* *per* Bushel,	is		5	8
40 of Barley,	at 2*s.* *per* Bushel,	is		4	0
The Sum of their given Quantities is 96, and their Value is				14	8

Then say, by the Rule of Three Direct, if 96 Bushels cost or is worth 14*l.* 8*s.* what is one Bushel worth?

Bush.	*l.*	*s.*	*Bush.*
96	14	8	1 Bushel.

$$\begin{array}{r} 20 \\ \hline 96)\ 288\ (3\,s. \\ 288 \\ \hline (0) \end{array}$$

Facit 3*s.* *per* Bushel.

Quest. 2. A Vintner mingled 15 Gallons of Canary at 8*s.* *per* Gallon, with 20 Gallons of Malaga at 7*s.* 6*d.* *per* Gallon, with 10 Gallons of Malaga at 6*s.* 8*d.* *per* Gallon, and 24 Gallons of White-wine at 4*s* *per* Gallon; now I demand what a Gallon of this Mixture is worth? Work as in the last Question, and you will find the Answer to be 6*s.* 2*d.* 2*qrs.* $\frac{45}{69}$.

Quest. 3. A Grocer hath mingled 3C. of Sugar at 56*s.* *per* C. with 3C. of Sugar at 3*l.* 14*s*, 8*d.* *per* C. and with 6C. at 1*l.* 17*s.* 4*d.* *per* C. I desire to know the Price of a C.wt. of that Mixture? *Answer* 2*l.* 17*s.* 1*d* $\frac{7}{13}$.

3. The Proof of this Operation is, by the Price of any Quantity of the Mixture, to find out the total Value of the whole Composition, and if it is equal to the total Value of the several Simples, the Work is right, otherwise not. (*The Proof of* Alligation Medial.) As in the first Example, the Answer to the Question was that 3*s.* is the Price of 1 Bushel; wherefore I say, by the Rule of Proportion, if 1 Bushel be 3*s.* what is 96 Bushels? *Answer* 14*l.* 8*s.* which is the total Value of the several Simples; wherefore the Work is right.

CHAP. XVIII.

Alligation Alternate.

1. ALligation alternate is, when there are given the particular Prices of several Simples, and thereby we discover such Quantities of those Simples, as being mingled together, shall bear a certain Rate propounded.

2. When

2. When such a Question is stated, place the given Prices of the Simple one over the other, and the propounded Price of the Composition against them in such Sort that it may represent a Root, and they as so many Branches springing from it, as in the following Example

Quest. 1. A certain Farmer is desirous to mix 20 Bushels of Wheat at 5*s*. or 60*d*. *per* Bushel, with Rye at 3*s* or 36*d*. *per* Bushel, and with Barley at 2*s*. or 24*d*. *per* Bushel, and Oats at 1*s*. 6. *per* Bushel, and desireth to mix such a Quantity of Rye, Barley and Oats, with the 20 Bushels of Wheat, as that the whole Composition may be worth 2*s*. 8*d*. or 32*d*. *per* Bushel.

The Prices of the Simples being placed according to the last Rule (with the Price of the Composition propounded as a Root to them) will stand as followeth.

$$32\begin{cases}60 \text{ Pence}\\36\\24\\18\end{cases}$$

3. Having thus placed the given Numbers, you are to link the several Rates of the Simples one to the other, by certain Arches, in such sort that one that is lesser than the mean Rate, may be coupled to another that is greater than the mean Rate; so the Question last propounded will stand,

1. *Thus,*

$$32\begin{cases}60\\36\\24\\18\end{cases}$$

2. *Or thus,*

$$32\begin{cases}60\\36\\28\\18\end{cases}$$

3. *or thus,*

$$32\begin{cases}60\\36\\24\\18\end{cases}$$

4. Then take the Difference between the Root and the several Branches, and place the Difference of each against the Number or Branch with which it is coupled or linked, and having taken all the Differences and placed them as aforesaid, then those Differences so placed will shew you the Number of each Simple to be taken to make a Composition to bear the mean Rate propounded.

So the Branches of the last Question being linked together, as in the manner, I say, the Difference between 32 and 60 is 28, which I put against 18, because 60 is linked with 18; then the Difference between 32 and 36 is 4, which I put against 24, because 36 is linked or coupled with 24; then I say, the Difference between 32 and 24 is 8, which I place against 36 (for the Reason aforesaid) then I say, the Difference between 32 and 18 is 14, which I place against 60, and then the Work will stand as you see in the Margent.

$$32\begin{cases}60\\36\\24\\18\end{cases}\quad\begin{array}{|r}14\\8\\4\\28\end{array}$$

So

So I conclude that a Composition made of 14 Bushels of Wheat at 60*d. per* Bushel, and 8 Bushels of Rye at 36*d. per* Bushel, and 5 bushels of Barley at 24*d. per* Bushel, and 28 Bushels of Oats at 18*d. per* Bushel, will bear the mean Price of 32*d.* or 2*s.* 8*d. per* Bushel. And here observe, that in the Composition there is but 14 Bushels of Wheat, but I would mingle 20 Bushels; and this Kind (or rather Case) of Alligation Alternate, *viz.* when there is given a certain Quantity of one of the Simples, and the Quantities of the rest sought to mingle with this given Quantity, that the Whole may bear a Price propounded) is called Alternation partial.

And the Proportion to find out the several Quantities to be mingled with the given Quantity, is thus,

As the Difference annexed to the Branch, that is, the Value of an Integer of the given Quantity, is to the other particular Differences, so is the Quantity given to the several Quantities required.

So here, to find how much Rye, Barley and Oats must be mingled with the 20 Bushels of Wheat, I say, by the Rule of Three Direct, if 14 Bushels of Wheat require 8 Bushels of Rye, what will 20 Bushels of Wheat require? *Answer*, $11\frac{5}{14}$ Bushels of Rye.

Again, if 14 Bushels of Wheat require 4 Bushels of Barley, what will 20 Bushels of Wheat require? *Ans.* $5\frac{10}{14}$ Bushels of Barley. Again, I say, if 14 Bushels of Wheat require 28 Bushels of Oats, what will 20 Bushels of Wheat require? *Ans.* 40 Bushels of Oats.

And now I say, that 20 Bushels of Wheat mingled with $11\frac{5}{14}$ Bushels of Rye, and $5\frac{10}{14}$ Bushels of Barley, and 40 Bushels of Oats, each bearing the Rate as aforesaid, will make a Composition, or Heap of Corn, that may yield 32*d. per* Bushel.

But if the Branches had been coupled according to the second Order or Manner, the Differences would have been thus placed, *viz.* the Difference between 33 and 60 is 28, which I set against 24, because 60 is linked thereto; and the Difference between 32 and 36 is 4, which I set against 18; and the Difference between 32 and 24 is 18, which I set against 60; then the Difference between 32 and 18 is 14, which I set against his Yoke-fellow 36; and then I conclude, that if you mix'd 8 Bushels of Wheat with

$$32\begin{cases}60 & 8\\36 & 14\\24 & 28\\18 & 4\end{cases}$$

with 14 Bushels of Rye, 28 Bushels of Barley, and 4 Bushels of Oats, each bearing the aforesaid Prices, the whole Mixture may be sold for 32*d. per* Bushel, as by the Work in the Margent.

You see by this Work we have found how many Bushels of Rye, Barley and Oats ought to be mixed with 8 Bushels of Wheat, and to find out how many of each ought to be mixed with 20 Bushels of Wheat, I say, as 1 is to 14, so is 20 to 35 Bushels of Rye. As 8 is to 28, so is 20 to 70 Bushels of Barley. As 8 is to 4, so is 20 to 10 Bushels of Oats; whereby I conclude, that if to 20 Bushels of Wheat I put 35 Bushels of Rye, 70 Bushels of Barley, and 10 Bushels of Oats, each bearing the aforesaid Price *per* Bushel, that then a Bushel of this Mixture will be worth 32*d*. or 2*s*. 8*d*.

And if the Branches had been linked as you see in the 3d Place, were each Branch bigger than the Root is link'd to two that are lesser than the Root, then in this Case you must have placed the several Differences between the Root and Branches against those two with which each is coupled; as first, the Difference between 32 and 60 is 28, which I set against 24 and 18, because it is coupled with them both;

32	60	8	14	22
	36	8	14	22
	24	28	4	32
	18	28	4	32

then the Difference between 32 and 36 is 4, which I set likewise against 3 and 18, because 36 is linked to them both; then the Difference between 32 and 24 is 8, which I put against 60 and 36, because 24 is linked to them both, then the Difference between 32 and 18 is 14, which I put against 60 and 36, the Yoke-fellows of 18.

Lastly, I draw a Line behind the Differences, and add the Differences which stand against each Branch, and put the Sum behind the said Line against its proper Branch, as you see in the Margent

And now by this Work I find that 22 Bushels of Wheat mingled with 22 Bushels of Rye, and 32 Bushels of Barley, and 32 Bushels of Oats, each bearing the said Price, will make a Mixture bearing the mean Rate of 32*d. per* Bushel.

And now to find how much of each of the rest must be mingled with 20 Bushels of Wheat, I say,

As 22 is to 32, so is 20 to 29 Bushels of Rye. As 22 is to 32, so is 20 to $19_{3}\frac{1}{2}$ Bushels of Barley. As 22 is to 32, so is 20 to $29_{3}\frac{1}{2}$ Bushels of Oats.

Whereby you see the Questions of Alligation Alternate will admit of more true Answers than one: for we have found three several Answers to this first Question.

The Proof of Alternation partial.

Questions of Alligation partial are proved the same way with Questions in Alligation medial, which you may see in the 3d Rule of the 17th Chapter.

Quest. 3. A Grocer hath 4 sorts of Sugar, *viz.* of 12*d.* *per* ℔, of 10*d* *per* ℔, of 6*d.* *per* ℔, and of 4*d.* *per* ℔, and would have a Composition worth 8*d.* *per* ℔, the whole Quantity whereof should contain 144℔ made of these four Sorts? I demand how much of each he must take?

Questions of this Nature are resolved by that Part of Alligation Alternate, called by Arithmeticians *Alligation Total, viz.* where there is given the Sum and Prices of several Simples, to find out how much of each Simple ought to be taken to make the said Sum or Quantity, so that it may bear a certain Rate propounded.

To resolve this Question, I place the several Prices of the Simples and mean Rate propounded, and link them together, as is directed in the 2d and 3d Rules of this Chapter, and place the Differences between the Root and Branches, according to the 4th Rule of this Chapter, which will then stand one of these three Ways, *viz.*

First

8	12	4
	10	2
	6	2
	4	4
		12

Second

8	12	2
	10	4
	6	4
	4	2
		12

Third

8	12	2, 4	6
	10	2, 4	6
	6	4, 2	6
	4	4, 2	6
			24

5. Then add the several Differences together, which I have done, and the Sums of the first and second Order are

12℔

12lb and of the third 24lb as you see above. But it required that there should be 144lb of the Composition, therefore to find the Quantity of each Simple to make the whole Composition 144lb, observe this general Rule, *viz.*

As, the Sum of the Differences is to the several Differences, so is the total Quantity of the Composition to the Quantity of each Simple.

So to find how much of each Sort of Sugar I ought to take to make 144lb at 8*d* *per* lb.

As 12 is to 4, so is 144 to 48lb at 12*d.* *per* lb.
As 12 is to 2, so is 144 to 24lb at 10*d.* *per* lb.
As 12 is to 2, so is 144 to 24lb at 6*d.* *per* lb.
As 12 is to 4, so is 144 to 48lb at 4*d* *per* lb.

Whereby I find that 18lb. at 12*d* *per* lb, and 24lb at 10*d.* *per* lb, and 24lb at 6*d.* *per* lb, and 48lb at 4*d.* *per* lb, will make a Composition of Sugar containing 144lb worth 8*d.* *per* lb.

But as the Branches are linked in the second Order, the Answer will be 24lb at 12*d.* *per* lb. and 48lb at 10*d.* *per* lb, and 43lb at 6*d.* *per* lb and 24lb at 4*d* *per* lb, to make the said Quantity, and to bear the said Price.

And if you had worked as the Branches are linked from the third Order, then you would have found the Quantity of 36lb of each.

Quest. 3. A Vintner hath 4 Sorts of Wine, *viz.* Canary at 10*s.* *per* Gallon, Malaga at 8*s.* *per* Gallon, Rhenish Wine at 6*s.* *per* Gallon, and White Wine at 4*s.* *per* Gallon, and he is minded to make a Composition of them all of 60 Gallons, that they may be worth 5*s* *per* Gallon, I desire to know how much of each he must have?

The Number of Terms being ranked according to the second Rule of this Chapter, the Branches will be linked as followeth, but will admit of no other manner of coupling, because there is but one Branch that is lesser than the Root, therefore all the rest must be linked unto it; and the Differences between the Root and the three first Branches, *viz.* 10, 8 and 6, which are 5, 3 and 1, must be set against 4, because they are coupled with it; and the Difference between the Root, *viz.* 5 and 4, which is 1, must be set against the three

5	10	1	1
	8	1	1
	6	1	1
	4	5, 3, 1	9

three

three other, because it is linked to them all; so I find 1 Gal. of Canary, 1 Gal. of Malaga, 1 Gal. of Rhenish Wine, and 9 Gallons of White Wine, priced as above, being mingled together, will be worth 5*s. per* Gallon, the Sum being 12 Gallons; but there must be 60 Gallons, wherefore I say,

As 12 is to 1, so is 60 to 5 Gallons of Canary.
As 12 is to 1, so is 60 to 5 Gallons of Malaga.
As 12 is to 1, so is 60 to 5 Gallons of Rhenish.
As 12 is to 9, so is 60 to 45 Gallons of White Wine.

so that 5 Gallons of Canary, 5 Gallons of Malaga, 5 Gallons of Rhenish, and 45 of White Wine mingled together, will be in all 60 Gallons worth 5*s. per* Gallon, which was required.

Quest. 4. A Goldsmith hath Gold of four several Sorts of fineness, *viz.* of 24 Carects fine, and of 22 Carects fine, and of 20 Carects fine, and of 15 Carects fine, (*Read Chap.* 2. *Def. of this Book*) and he would mingle so much of each with Alloy, that the whole Mass of 28*oz.* of Gold so mingled may bear 17 Carects fine; I demand how much of each he must take? The 2d and 3d Rules of this Chapter being observed) (for instead of the Alloy I put 0, because it bears no Fineness, but it makes a Branch in the Operation) the Terms may be alligated, and the Differences added by any of these four Ways following, *viz.*

First thus,

17	24	.17	17
	22	.2	2
	20	.2, .17	19
	15	.5, .3	8
	0	.7, .3	10
		Sum	56

Secondly thus,

17	24	.2	2
	22	.17	17
	20	.2, .17	19
	15	.7, .3	10
	0	.5, .3	8
		Sum	56

Thirdly,

Thirdly thus,

	24	3	2
	22	2,	2
17	20	2, 17	19
	15	7, 5, 3.	15
	0	3,	3
		Sum	41

Fourthly thus,

	24	2, 17,	19
	22	2, 17,	19
17	20	2, 17,	19
	15	7, 5, 3,	15
	0	7, 5, 3,	15
		Sum	87

More Ways may be given for the alligating or linking of the Terms in this Question, but these, if well practised, are sufficient for understanding the Rules of Alligation

In Questions of Alligation Total the Answer is given true, when the Sum of each of the Quantities of Simples found, (*The Proof of* Alternation Total) agrees with the Sum or Quantity propounded; as in the last Question, the Answer was 8*oz.* 10*pwt.* of 24 Carects fine, 1*oz.* of 22 Carects fine, 9*oz.* 10*pwt.* of 20 Carects fine, 4*oz.* of 15 Carects fine, and 5*oz.* of Alloy, which added together make 28*oz.* the Quantity propounded.

CHAP. XIX.

Reduction of Vulgar Fractions.

1. WHAT a Vulgar Fraction is, hath been already shewed in the first Chapter of this Book, to which I refer the Reader to look cautiously into.

2. To reduce a Vulgar Fraction, observe carefully these eight following Rules,

1. To reduce a mix'd Number into an improper Fraction.

2. To reduce a whole Number into an improper Fraction.

3. To reduce an improper Fraction into its equivalent whole (or mix'd) Number

4. To reduce a Fraction into the lowest Terms equivalent to the Fraction given.

5. To find the Value of a Fraction in the known Parts of Coin, Weight, Measure, *&c.*

6. To reduce a compound Fraction to a simple one of the same Value.

7. To reduce diverse Fractions having unequal Denominations, to Fractions of the same Value having an equal Denominator.

8. To reduce a Fraction of one Denomination to another of the same Value.

I. *To reduce a mix'd Number to an improper Fraction.*

The Rule is,

Multiply the Integer Part (or whole Number) by the Denominator of the Fraction, (*Vide Chap.* 1. *Defin.* 31) and to the Product add the Numerator, and that Sum place over the Denominator for a new Numerator, so this new Fraction shall be equal to the mix'd Number given. As for Example:

1 Reduce $18\frac{3}{7}$ into an improper Fraction; multiply the whole Number 18 by 7 the Denominator, and to the Product add the Numerator 3, the Sum is 129, which put over the Denominator 7, and it makes $\frac{129}{7}$ for the Answer, as followeth.

$$\begin{array}{rr} & 18\frac{3}{7} \\ & 7 \\ \hline \textit{Facit} & 129 \\ \hline & 7 \end{array}$$

2. Reduce $113\frac{5}{21}$ to an improper Fraction, *facit*, $\frac{2201}{21}$.
3. Reduce $50\frac{13}{21}$ to an improper Fraction, *facit*, $\frac{1180}{21}$.

II. *To reduce a whole Number into an improper Fraction.*

The Rule is, Multiply the given Number by the intended Denominator, and place the Product for the Numerator over it. (*Vide Chap.* 1. *Defin.* 23) As for Example:

1. Let it be required to reduce 15 into a Fraction whose Denominator shall be 12. To effect which, I multiply 15 by the intended Denominator (12) the Product is 180, which I place over 12 as a Numerator, and it makes $\frac{180}{12}$, which is equal to 15, as was required; as *per* Margent.

$$\begin{array}{rr} & 15 \\ & 12 \\ \hline & 30 \\ \textit{Facit}\ \frac{180}{12} & 15 \\ \hline & 180 \end{array}$$

2. Reduce

2. Reduce 36 into an improper Fraction, whose Denominator shall be 26, *facit* $\frac{936}{26}$.

3. Reduce 135 into an improper Fraction, whose Denominator shall be 16, *facit* $\frac{2160}{16}$.

III. *To reduce an improper Fraction into its equivalent whole or mix'd Number.*

The Rule is, Divide the Numerator by the Denominator, and the Quotient is the whole Number equal to the Fraction; and if any Thing remain, put it for a Numerator over the Divisor. *Example.*

1. Reduce $\frac{436}{8}$ into its equivalent mix'd Number. Divide the Numerator 436 by the Denominator 8, and the Quotient is 54, and 3 remains, which put for a Numerator over the Divisor 8, the Answer is $54\frac{4}{8}$, as followeth,

$$
\begin{array}{l}
8)436(54 \\
\underline{40} \\
36 \\
\underline{32} \\
(4)
\end{array}
\qquad \textit{Facit } 54\tfrac{4}{8}
$$

2. Reduce $\frac{1476}{15}$ to a mix'd Number. *Facit* $231\frac{1}{15}$.

3. Reduce $\frac{25576}{138}$ to a mix'd Number. *Facit* 1[illegible]4$\frac{72}{138}$.

IV. *To reduce a Fraction into its lowest Terms, equivalent to the Fraction given.*

The Rule is, 1. If the Numerator and Denominator are even Numbers, take half the one and half of the other, as often as may be, and when either of them falls out to be an odd Number, then divide them by any Number that you can discover will divide both Numerator and Denominator without any Remainder; and when you have thus proceeded as low as you can reduce them, then this new Fraction so found out shall be the Fraction you desire, and will be equal in Value to the given Fraction.

Example 1. Let it be required to reduce $\frac{192}{336}$ into its lowest Terms. First I take the half of the Numerator 192, and it is 96, then half of the Denominator, and it is 168, so that it is brought to $\frac{96}{168}$, and next to $\frac{48}{84}$, and by halfing still to $\frac{24}{42}$, and their half is $\frac{12}{21}$, and now I can no longer half it, because 21 is an odd Number, wherefore I try to divide them by 3, 4, 5, 6,

192	96	48	12	12	4
336	168	84	24	21	7

6, &c. and I find 3 divides them both without any Remainder, and brings them to $\frac{4}{7}$, as *per* Margent.

So I conclude $\frac{4}{7}$ thus found to be equal in Value to the given Fraction $\frac{192}{336}$.

2. What is $\frac{1736}{1984}$ in its lowest Terms? *Answer* $\frac{7}{8}$.

3. What is $\frac{1342}{1586}$ in its lowest Terms? *Answer* $\frac{11}{13}$

The best way to reduce a Fraction into its lowest Terms is, by finding a common Measure, *viz.* the greatest Number that will divide the Numerator and Denominator without any Remainder, and by that means reduce a Fraction to its lowest Terms at the first Work; and to find out this common Measure, divide the Denominator by the Numerator, and if any Thing remain divide your Divisor thereby, and if any Thing yet remain, then divide your last Divisor by it; do so until you find nothing remaining; then this last Divisor shall be your greatest common Measure, which will divide both Numerator and Denominator, and reduce them both into their lowest Terms at one Work.

Example 4. Reduce $\frac{228}{304}$ into its lowest Terms by a common Measure; to effect which I divide the Denominator 304 by the Numerator 228, and there remains 76; then I divide 228 (the first Divisor) by 76 (the Remainder) and it quotes 3, and nothing remains; wherefore the last Divisor 76 is the common Measure, by which I divide the Numerator of the given Fraction, *viz.* 228, it quotes 3 for a new Numerator; then I divide the Denominator 304 by 76, and it quotes 4 for a new Denominator, so that now I have found $\frac{3}{4}$ equal to $\frac{228}{304}$

5. Reduce $\frac{6048}{7392}$ into its lowest Terms by a common Measure, *facit* $\frac{9}{11}$.

6. Reduce $\frac{4081}{26382}$ into its lowest Terms by a common Measure, *facit* $\frac{13}{86}$

A Compendium.

Note, That if the Numerator and Denominator of a Fraction end each with a Cypher or Cyphers, then cut off as many Cyphers from the one as from the other, and the remaining Figures will be a Fraction of the same Value, *viz.* $\frac{3400}{7100}$ will be found to be reduced to $\frac{34}{71}$, by cutting off the two Cyphers from the Numerator and Denominator with a Dash of the Pen, thus, $\frac{34|00}{71|00}$, and $\frac{450}{760}$ will be $\frac{45}{76}$, thus, $\frac{45|0}{76|0}$, &c.

V. *To*

V. *To find the Value of a Fraction in the known Parts of Coin Weights,* &c.

The Rule is, Multiply the Numerator by the Parts of the next inferior Denomination that are equal to an Unit of the ſame Denomination with the Fraction; then divide the Product by that Denominator, and the Quote gives you its Value in the ſame Parts you multiplied by, and if any Thing remain, multiply it by the Parts of the next inferior Denomination, and divide as before; do ſo till you can bring it no lower, and the ſeveral Quotients will give you the Value of the Fraction as was required; and if any at laſt remain, place it for a Numerator over the former Denominator. Some few Examples will make the Rule plain.

1. What is the Value of $\frac{27}{29}$ *l. ſterling?* To anſwer this Queſtion, I multiply the Numerator 27 by 20, (the Shillings in a Pound) the Product is 540, which I divide by 29 (the Denominator) and the Quotient is 18*s.* and there remains 18, which I multiply by 12 Pence, and the Product (216) I divide by the Denominator 29, the Quotient is 7 *d* and 13 remains, which I multiply by 4 Farthings, the Product is 52, which I ſtill divide by 29, the Quotient is 1 *qr.* and there remaineth 23, which I put for a Numerator over the Denominator 29, ſo I find the Value of $\frac{27}{29}$ *l.* to be 18*s.* 7*d.* 1*qr.* $\frac{23}{29}$, as by the Work in the Margent, and after the ſame manner the Value of $\frac{11}{15}$ of a Pound *Sterling* is found out to be 14 *s.* 8 *d.*

$\frac{27}{29}$ *l.*

```
            27
Multiply    20
       29) 540 (18s. 7d. 1 23/29 q.
            29
           250
           232
Rem.      (18)
Mult.       12
            36
           18
       29) 216 (7d.
           203
Rem.      (13)
Mult.        4
               qr.
       29) 52 (1 23/29
           29
Rem.      (23)
```

	s.	d.	qr.
Facit	18	7	1 $\frac{23}{29}$

And ſo likewiſe you may find the Value of any Fraction either in Weight or Time, &c.

 VI. *To*

VI. *To reduce a compound Fraction to a Simple of the same Value.*

What a compound Fraction is, hath been shewn in *Chap.* 1. *Definition* 24, and to reduce it to a simple Fraction of the same Value.

The Rule is, Multiply the Numerators continually, and place the last Product for a new Numerator, then multiply the Denominators continually, and place the last Product for a new Denominator; so this single Fraction shall be equal to the compound Fraction.

Example.

1. Reduce $\frac{2}{3}$ of $\frac{3}{5}$ of $\frac{5}{8}$ to a simple Fraction.

Multiply the Numerators 2, 3 and 5 together, they make 30 for a new Numerator; then I multiply the Denominators 3, 5 and 8 together, and their Product is 120 for a Denominator, so the simple Fraction is $\frac{30}{120}$, and cutting off the Cyphers it is $\frac{3}{12}$, equal to the $\frac{1}{4}$ by the 4th Rule following.

$$\begin{array}{r} 5 \\ 3 \\ \hline 15 \\ 8 \\ \hline 120 \end{array} \qquad \begin{array}{r} 3 \\ 2 \\ \hline 6 \\ 5 \\ \hline 30 \end{array}$$

Facit $\frac{30}{120}$, or $\frac{3}{12}$, or $\frac{1}{4}$.

2. What is $\frac{7}{10}$ of $\frac{5}{9}$ of $\frac{4}{7}$ of $\frac{11}{12}$? *Answ.* $\frac{1540}{7560}$, or $\frac{154}{756}$, or $\frac{77}{378}$ in its lowest Terms.

3. What is $\frac{11}{12}$ of $\frac{13}{14}$ of $\frac{21}{29}$? *Answer* $\frac{3003}{4872}$

By this you may know how to find the Value of a compound Fraction, *viz.* first reduce it to a simple one, and then find out its Value by the 5th Rule foregoing.

Example 4. What is the Value of $\frac{3}{4}$ of $\frac{5}{6}$ of $\frac{9}{12}$ of a Pound? *Answer* 11s. 3d.

VII. *To reduce Fractions of unequal Denominations to Fractions of the same Value, having equal Denominators.*

The Rule is, Multiply all the Denominators together, and the Product shall be the common Denominator; then multiply each Numerator into all the Denominators, except its own, and the last Product put for a Numerator over the Denominator found out as before; so this new Fraction is equal to that Fraction whose Numerator you multiply into the said Denominator. Do so by all the Numerators given, and you have your Desire.

Example.

Example.

1. Reduce $\frac{3}{4}$, $\frac{4}{5}$, $\frac{5}{6}$ and $\frac{7}{8}$ to a common Denominator. Multiply the Denominators 4, 5, 6 and 8 together continually, and the Product is 960 for the common Denominator; then multiply the Numerator 3 into the Denominators 5, 6 and 8, and the Product is 720, which is a Numerator to 960 (found as before) so $\frac{720}{960}$ is equal to the first Fraction $\frac{3}{4}$; then I proceed to find a new Numerator to the second Fraction, *viz* $\frac{4}{5}$, and I multiply 4 (into all the Denominators except its own, *viz.*) into 4, 6 and 8, which produceth $\frac{768}{960}$ equal to $\frac{4}{5}$, then multiply the Numerator 5 into the Denominators 4, 5 and 8, the Product is $\frac{800}{960}$, equal to $\frac{5}{6}$, then multiply the Numerator 7 into the Denominators 4, 5 and 6, the Product is $\frac{840}{960}$, equal to $\frac{7}{8}$ and the Work is done: so that for $\frac{3}{4}$, $\frac{4}{5}$, $\frac{5}{6}$ and $\frac{7}{8}$ I have $\frac{720}{960}$, $\frac{768}{960}$, $\frac{800}{960}$ and $\frac{840}{960}$.

2 Reduce $\frac{11}{12}$, $\frac{14}{23}$ and $\frac{19}{21}$ to a common Denominator, *faciunt* $\frac{5313}{5796}$, $\frac{3528}{5796}$ and $\frac{5244}{5796}$.

VIII. *To reduce a Fraction of one Denomination to another.*

1. This is either ascending or descending. Ascending, when a Fraction of a smaller is brought to a greater Denomination: Descending, when a Fraction of a greater Denomination is brought lower.

2. When a Fraction is to be brought from a lesser to a greater Denomination, then make of it a compound Fraction, by comparing it with the intermediate Denominations between it, and that you would have it reduced to; then (by the 6th Rule foregoing) reduce your Compound to a simple Fraction, and the Work is done.

Example.

Quest. 1. It is requir'd to know what Part of a Pound *Sterling* $\frac{5}{7}$ of a Penny is?

To resolve this, I consider that 1*d.* is $\frac{1}{12}$ of a Shilling, and a Shilling is $\frac{1}{20}$ of a Pound; wherefore $\frac{5}{7}$*d.* is $\frac{5}{7}$ of $\frac{1}{12}$ of $\frac{1}{20}$ of a Pound, which, by the said 6th Rule, I find to be $\frac{5}{1680}$ of a Pound *Sterl.* of *English* Money.

Quest. 2 What Part of a Pound *Troy* Weight is $\frac{4}{5}$ of a Penny-weight? *Ans* $\frac{4}{5}$ of $\frac{1}{20}$ of $\frac{1}{12}$ equal to $\frac{4}{1200}$ *Troy.*

3. When a Fraction is to be brought from a greater to a lesser Denomination, then multiply the Numerator by the Parts contained in the several Denominations betwixt it and the

the Parts you would reduce it to; then place the last Product over the Denominator of the given Fraction.

Example.

Quest. 3. I would reduce $\frac{3}{5}$ *l.* to the Fraction of 1*d.* to do which, I multiply the Numerator 3 by 20 and 12, the Product is 720, which I put over the Denominator 5, it makes $\frac{720}{5}$ of 1*d.* equal to $\frac{3}{5}$*l.*

Quest. 4. What Part of an Ounce *Troy* is $\frac{5}{18}$ ℔? *Answer* $\frac{60}{18}$ oz.

CHAP. XX.

Addition of Vulgar Fractions.

1. IF your Fractions to be added have a common Denominator, then add all the Numerators together, and place their Sum for a Numerator to the common Denominator, which new Fraction is the Sum of all the given Fractions; and if it be improper, reduce it to a whole or mix'd Number, by the 3d Rule in the 19th Chapter.

Quest. 1. What is the Sum of $\frac{7}{24}$, $\frac{9}{24}$ $\frac{16}{24}$ and $\frac{14}{24}$?

The Denominators are equal, *viz.* every one is 24; wherefore add the Numerators together, *viz.* 7, 9, 16 and 14, their Sum is 46. which put over the Denominator 24, it makes $\frac{46}{24}$, the Sum of the given Fractions, which will be reduced to the mix'd Numbers $1\frac{22}{24}$ or $1\frac{11}{12}$.

2. But if the Fractions to be added have unequal Denominators, then reduce them to a common Denominator by the 7th Rule of Chap. 19, and then add the Numerators together, and put the Sum over the common Denominator, &c. as before in the last Example.

Quest. 2. What is the Sum of $\frac{2}{5}$, $\frac{7}{8}$ $\frac{9}{10}$ and $\frac{11}{12}$?

The Fractions reduced to a common Denominator are $\frac{1980}{4800}$ $\frac{4300}{4800}$, $\frac{4320}{4800}$ and $\frac{4400}{4800}$, the Sum of their Numerators is 14900, which put over the common Denominator makes $\frac{14900}{4800}$, or $\frac{149}{48}$, equal to the mix'd Number $3\frac{5}{48}$ for the Sum required.

Quest. 3 What is the Sum of $\frac{13}{17}$, $\frac{21}{49}$ and $\frac{35}{47}$?

Answer. $1\frac{37555}{39151}$.

3. If you are to add mix'd Numbers together, then add the fractional Parts as before, and if their Sum be an improper Fraction, reduce it to a mix'd Number, and add its integral Part to the integral Parts of the given mix'd Numbers, and the Work is done.

Quest.

Quest. 4. What is the Sum of $13\frac{3}{4}$ and $24\frac{5}{8}$?

First add the Fractions $\frac{3}{4}$ and $\frac{5}{8}$: the Sum is $1\frac{12}{32}$, then add the Integer 1 to 13 and 24, their Sum is 38, and put after it the Fraction $\frac{12}{32}$, it is $38\frac{12}{32}$ for the Answer, or it is $38\frac{3}{8}$.

Quest. 5. What is the Sum of $48\frac{3}{7}$, $64\frac{5}{8}$ and $130\frac{3}{4}$?

Facit $243\frac{180}{224}$. or $243\frac{45}{56}$.

4. If any of the Fractions to be added is a compound Fraction, it must first be reduced to a simple Fraction by the 6th Rule of Chapter 19, and then add it to the rest, according to the 2d Rule of this Chapter.

Example.

Quest. 6. What is the Sum of $\frac{3}{4}$, $\frac{5}{6}$ and $\frac{7}{8}$ of $\frac{3}{4}$ of $\frac{5}{6}$?

Reduce $\frac{7}{8}$ of $\frac{3}{4}$ of $\frac{5}{6}$ into a simple Fraction, and it is $\frac{105}{192}$. which reduced with the other two, and added, are $2\frac{600}{4608}$.

Quest. 7. What is the Sum of $\frac{11}{12}$ of $\frac{3}{4}$ of $\frac{4}{5}$ of $\frac{5}{6}$?

Answer $1\frac{5}{12}$

5. If the Fractions to be added are not of one Denomination, they must be so reduced, and then proceed as before.

Quest. 8. What is the Sum of $\frac{3}{4}$ *l.* and $\frac{5}{6}$ *s.*?

Of the given Fractions here, one is of a Pound, and the other the Fraction of a Shilling; and before you can add them together you must reduce $\frac{5}{6}$ *s.* to the Fraction of a Pound as the other is (by the 8th Rule of Chap. 19.) and it makes $\frac{5}{120}$ *l.* then $\frac{3}{4}$ and $\frac{5}{120}$ *l.* will be found to be $\frac{380}{480}$ *l.* or $\frac{38}{48}$ *l.* by the 7th Rule of Chap. 19. and in its lowest Terms $\frac{19}{24}$ *l.* by the 4th Rule of Chap. 19.

It would have been the same (if by the latter Part of the 8th Rule of Chapter 19.) you had reduced $\frac{3}{4}$ *l* to the Fraction of a Shilling, which you would have found to have been $\frac{60}{4}$ *s.* which added to $\frac{5}{6}$ *s* by the said 17th Rule of the last Chapter, the Sum is 15 *s.* $\frac{20}{24}$, which is equal to the Sum found, as before, *viz.* $\frac{19}{24}$ *l.* for (by the 5th Rule of Chapter 19.) the Value of $\frac{19}{24}$ *l.* will be found to be 15 *s.* 10 *d.* and so will 15 *s.* $\frac{20}{24}$ be found to be just as much.

Quest. 9. What is the Sum of $\frac{2}{3}$ *l.* $\frac{2}{3}$. and $\frac{2}{3}$ *d.*?

Ans. $\frac{2558500}{3600000}$ or $\frac{25585}{36000}$ *l.* or in its lowest Terms $\frac{5110}{7200}$.

CHAP.

CHAP. XXI.

Subtraction of Vulgar Fractions.

1. THE Rules in *Addition* for reducing the given Fractions to one Denomination, are here to be observed; for before Subtraction can be made, the Fractions must be reduced to a common Denominator; then subtract one Numerator from the other, and place the Remainder over a common Denominator, which Fraction shall be the Excess or Difference between the given Fractions.

Examples

Quest. 1 What is the Difference between $\frac{3}{4}$ and $\frac{5}{7}$? The given Fractions are reduced to $\frac{21}{28}$, and $\frac{20}{28}$, then subtract the Numerator 20 from the Numerator 21, and there remains 1, which being put over the Denominator 28 makes $\frac{1}{28}$ for the Answer or Difference between $\frac{3}{4}$ and $\frac{5}{7}$.

Quest. 2. What is the Difference between $\frac{5}{6}$ and $\frac{3}{8}$ of $\frac{2}{4}$? Reduce the compound Fraction $\frac{3}{4}$ of $\frac{5}{8}$ to a simple Fraction, then proceed as before, and the Answer is $\frac{110}{140}$, equal to $\frac{11}{14}$.

2. When a Fraction is given to be subtracted from a whole Number, subtract the Numerator from the Denominator, and put the Remainder for a Numerator to the given Denominator, and subtract an Unit (for that you borrowed) for the whole Number, and the Remainder place before the Fraction found, as before, which mixed Number is the Remainder or Difference sought.

Example.

Quest 3. Subtract $\frac{7}{10}$ from 48.

Answer 47 $\frac{3}{10}$. for if you subtract 7 (the Numerator) from 10 (the Denominator) there remains 3, which put over 10 is $\frac{3}{10}$. and 1 (I borrowed) from 48 rests 47, to which join $\frac{3}{10}$, and it makes 47 $\frac{3}{10}$ for the Excess.

Quest. 4. Subtract $\frac{13}{18}$ from 57, remain 56 $\frac{5}{18}$.

3. If it be required to subtract a Fraction from a mix'd Number, or one mix'd Number from another, reduce the Fraction to a common Denominator, and if the Fraction to be subtracted be lesser than the other, then subtract the lesser Numerator from the greater, and that is a Numerator for the common Denominator; then subtract the lesser integral Part from the greater, and the Remainder, with the remaining Fractions thereunto annexed, is the Difference requir'd between the two given mix'd Numbers.

Example.

Quest. 5. Subtract $26\frac{3}{7}$ from $54\frac{5}{6}$.

First, subtract $\frac{3}{7}$, *viz.* $\frac{18}{42}$ from $\frac{5}{6}$, *viz.* $\frac{35}{42}$, the Remainder is $\frac{17}{42}$; then 26 from 54 remaineth 28, to which annex $\frac{17}{42}$ it makes $28\frac{17}{42}$ for the Answer.

4. But if the Fraction to be subtracted is greater than the Fraction from whence you subtract, then having first reduced the Fractions to a common Denominator, take the Numerator of the greatest Fraction out of the Denominator, and add the Remainder to the Numerator of the lesser Fraction, and their Sum is a new Numerator to the common Denominator, which Fraction note; then (for the 1 you borrowed) add 1 to the integral part to be subtracted, and subtract it from the greater Number, and to the Remainder annex the Fraction you noted before, so this new mix'd Number shall be the Difference sought.

Example

Quest. 6. Subtract $14\frac{3}{4}$ from $29\frac{4}{7}$.

The Fractions reduced are, *viz* $\frac{3}{4}$ equal to $\frac{21}{28}$, and $\frac{4}{7}$ equal to $\frac{16}{28}$; now I should subtract $\frac{21}{28}$, from $\frac{16}{28}$, but I cannot, therefore I subtract 21 from 28, rest 7, which added to 16 (the lesser Numerator) make 23 for a Numerator to 28, *viz* $\frac{23}{28}$; then I come to the integral Parts 14 and 29, and say, 1 that I borrowed and 14 is 15, which taken from 29 there rests 14, to which annexing $\frac{23}{28}$, it is $14\frac{23}{28}$, for the Remainder or Difference between $14\frac{3}{4}$ and $29\frac{4}{7}$.

Quest. 7. Subtract $36\frac{9}{10}$ from $74\frac{4}{9}$ *Facit* $37\frac{49}{90}$.

CHAP. XXII.

Multiplication of Vulgar Fractions.

1. IF the Multiplicand and Multiplier are simple Fractions then multiply the Numerators together for a new Numerator, and the Denominators for a new Denominator, and the new Fraction is the Product required.

Quest. 1. What is the Product of $\frac{5}{7}$ by $\frac{9}{11}$? *facit* $\frac{45}{77}$; for the Numerators 5 and 9 being multiplied make 45, and the Denominators 7 and 11 being multiplied make 77.

Quest. 2. What is the Product of $\frac{18}{25}$ by $\frac{21}{35}$? *facit* $\frac{378}{875}$.

2. If the Fractions to be multiplied be mix'd Numbers, reduce them to improper Fractions by the 1st Rule of the 19th Chapter, then proceed as before.

Quest. 3. What is the Product of $48\frac{3}{5}$ by $13\frac{5}{6}$?

The

The given mix'd Numbers being reduced to improper Fractions are $48\frac{3}{5}$ equal to $\frac{243}{5}$, and $13\frac{5}{6}$ equal to $\frac{83}{6}$; now $\frac{243}{5}$ multiplied by $\frac{83}{6}$, according to the 1st Rule of this Chapter, produceth $\frac{20169}{30}$, or $672\frac{9}{30}$.

Quest 4. What is the Product of $439\frac{5}{10}$ by $18\frac{3}{7}$? *facit* $\frac{55547}{70}$ or $793\frac{24}{70}$.

3. If a compound Fraction is to be multiplied by a simple Fraction, first reduce the compound Fraction into a simple Fraction, then multiply the one by the other, as is taught above.

Quest. 5. What is the Product of $\frac{16}{21}$ by $\frac{3}{4}$ of $\frac{5}{7}$ of $\frac{4}{5}$?

The compound Fraction $\frac{3}{4}$ of $\frac{5}{7}$ of $\frac{4}{5}$ reduded is $\frac{60}{140}$ or $\frac{6}{14}$, which multiplied by $\frac{16}{21}$ produceth $\frac{96}{294}$, which in its lowest Term is $\frac{16}{49}$ for the Answer.

And if the Multiplicand and Multiplier are both compound Fractions, reduce them both to simple ones, then multiply these few Fractions as before, so you have the Product.

Quest. 6. What is the Product of $\frac{3}{4}$ of $\frac{2}{3}$ of $\frac{3}{5}$ by $\frac{1}{2}$?

Answer $\frac{18}{120}$, in its lowest Term $\frac{3}{20}$.

Quest. 7. What is the Product of $\frac{2}{5}$ of $\frac{3}{4}$ by $\frac{3}{5}$ of $\frac{5}{6}$?

Answer $\frac{60}{360}$, or $\frac{6}{36}$, or in its least Term $\frac{1}{6}$.

4. If a Fraction be to be multiplied by a whole Number, put under the given whole Number an Unit for a Denominator, whereby it will be an improper Fraction, then multiply the Fractions as before.

Example.

Quest. 8. What is the Product of 24 by $\frac{2}{3}$?

Answer $\frac{48}{3}$; for 24 by putting an Unit under it will be $\frac{24}{1}$, and $\frac{24}{1}$ by $\frac{2}{3}$ produceth $\frac{48}{3}$ or 16.

Quest. 9. What is the Product of 36 by $\frac{9}{11}$?

Answer $\frac{324}{11}$, or $29\frac{5}{11}$?

CHAP. XXIII.

Division of Vulgar Fractions.

1. IF the Dividend and Divisor are both simple Fractions, then multiply the Numerator of the Dividend into the Denominator of the Divisor, and the Product is a new Numerator, and multiply the Denominator of the Dividend into the Numerator of the Divisor, and the Product is a new Denominator, which new Fraction thus found is the Quotient you desire.

Example.

Example.

Quest. 1. What is the Quotient of $\frac{5}{8}$ divided by $\frac{3}{5}$?

Ans. $\frac{25}{24}$, or $1\frac{1}{24}$; for first I multiply (5) the Numerator of the Dividend into (5) the Denominator of the Divisor, and the Product (25) is a Numerator for the Quotient, then I multiply (8) the Denominator of the Dividend into (3) the Numerator of the Divisor, and the Product (24) I put in the Quotient for a Denominator; so I find $\frac{25}{24}$ is the Quotient sought.

$$\frac{3}{5}\Big)\frac{5}{8}\Big(\frac{25}{24}$$

Quest. 2. What is the Quotient of $\frac{10}{21}$ divided by $\frac{2}{3}$?

Answer $\frac{30}{42}$, equal to $\frac{5}{7}$ in its lowest Terms.

2. But if you will divide a simple Fraction by a Compound, or a Compound by a Simple, first reduce such Compound to a simple Fraction, then go on as before.

Quest. 3. What is the Quotient of $\frac{3}{16}$ divided by $\frac{3}{4}$ of $\frac{2}{3}$?

Answer $\frac{36}{96}$ or $\frac{3}{8}$; first reduce $\frac{3}{4}$ of $\frac{2}{3}$ into a simple Fraction, and it is $\frac{6}{12}$, by which $\frac{3}{16}$ being divided, the Quotient is $\frac{36}{96}$, equal in its least Terms to $\frac{6}{16}$; and if the Dividend and Divisor be both of compound Fractions, reduce them both to a simple Fraction, then divide the one by the other, as in Rule 1. foregoing.

Quest. 4. What is the Quote of $\frac{2}{3}$ of $\frac{3}{4}$ divided by $\frac{2}{3}$ of $\frac{5}{8}$?

Answer $\frac{180}{120}$ or $\frac{18}{12}$, or $1\frac{6}{12}$, or $1\frac{1}{2}$ in its lowest Terms.

3. If the Dividend, or Divisor, or both, are mixed Numbers, reduce them to improper Fractions, and perform Division as you are taught before.

Quest. 5. What is the Quote of $12\frac{3}{4}$ divided by $21\frac{4}{5}$?

Answer $\frac{255}{436}$ for $12\frac{3}{4}$, is equal to $\frac{51}{4}$, and $21\frac{4}{5}$ is equal to $\frac{109}{5}$, and the Quote of $\frac{51}{4}$ divided by $\frac{109}{5}$ is as before $\frac{255}{436}$.

4. If you divide a Fraction by a whole Number, or a whole Number by a Fraction, make the whole Number an improper Fraction, by putting an Unit for a Denominator to it, as was taught in Rule 4. Chap. 22. and then perform Division as was before taught.

Example.

Quest. 6. What is the Quote of 8 divided by $\frac{3}{5}$?

Answer $\frac{40}{3}$, which is equal to $13\frac{1}{3}$, being reduced as is before directed. See the Work in the Margent.

$$\frac{3}{5}\Big)\frac{8}{1}\Big(\frac{40}{3} \text{ or } 13\tfrac{1}{3}.$$

$\frac{8}{1}\Big)\frac{3}{5}\Big(\frac{3}{40}$ *Quest.* 7. What is the Quotient of $\frac{3}{5}$ divided by 8?

Answer $\frac{3}{40}$, as *per* Margent.

CHAP. XXIV.

The Rule of Three Direct in Vulgar Fractions.

1. AS in the Rule of Three in whole Numbers, so likewise in Fractions, you must see that the Fractions of the first and third Places be of the same Denomination.

2. If any of the given Fractions be compound, let 'em be reduced to simple of the same Value.

3. If there are given mixed Numbers, reduce them to improper Fractions by the first Rule of Chap. 19.

4. If any of the three Terms is a whole Number, make it an improper Fraction, by constituting an Unit for its Denominator.

Having reduced your Fraction as is directed in the four last Rules, then proceed to a Resolution, which is performed the same way as in whole Numbers, Respect being had to the Rules delivered for the working of Fractions; *viz.* Multiply the 2d and 3d Fractions together, according to the first Rule of Chap. 22. and divide the Product by the first Fraction, according to the first Rule of Chap. 23. and the Quotient is the Answer

Or, (which is better)

5. Multiply the Numerator of the first Fraction into the Denominator of the second and third, and the Product is a new Denominator; then multiply the Denominator of the first Fraction into the Numerator of the second and third, and the Product is a new Numerator, which new Fraction is the fourth Proportional or Answer, which (if it be an improper Fraction) must be reduced to a whole or mix'd Number by the 3d Rule of Chap. 19.

Example.

Quest. 1. If $\frac{3}{4}$ Yards of Cloth cost $\frac{5}{8}$ *l.* what will $\frac{9}{10}$ Yards cost?

Having placed the given Fractions according to the 6th Rule of Chap. 10. I proceed to the Resolution, and first I multiply the Numerator of the first Fraction (3) into 8 and 10, the Denominators of the second and third Fractions, and the Product is 240 for a Denominator; then multiply 4 the Denominator of the first Fraction into 5 and 9, the

Numerators

Numerators of the second and third Fractions, the Product is 180 for a Numerator, which Numerator 180 and Denominator 240 make $\frac{180}{240}$*l.* for the Anſwer, equal to $\frac{3}{4}$ or 15*s.*

Yards	*l.*	*Yards*	*l.*
$\frac{3}{4}$	$\frac{5}{8}$	$\frac{9}{10}$	$\frac{180}{240}$

Facit $\frac{180}{240}$ *l.* equal to $\frac{3}{4}$

Queſt. 2. If $\frac{2}{3}$*l.* buy $\frac{5}{8}$ Yards of Cloth, what will $\frac{11}{12}$ Yards coſt at that Rate?

Anſwer $\frac{132}{180}$*l.* equal to $\frac{11}{15}$*l* or 14*s.* 8*d.*

Queſt. 3. If $\frac{7}{8}$*l.* coſt $\frac{3}{4}$*s.* what will $\frac{8}{9}$*s* buy?

Anſwer $\frac{224}{216}$*l.* equal to $1\frac{1}{27}$*l*

Queſt. 4. If $\frac{3}{5}$ of an Ell of Holland coſt $\frac{1}{3}$*l.* how much will $12\frac{2}{3}$ Ells coſt at that Rate?

Anſwer $\frac{190}{27}$ equal to $7\frac{1}{27}$*l.*

In reſolving the laſt Queſtion and the two next, obſerve the 3d Rule of the Chapter foregoing.

Queſt. 5. If $\frac{9}{10}$ of a *C.* coſt 284*s.* what will $7\frac{1}{2}$*C.* coſt at that Rate?

Anſwer $2366\frac{2}{3}$*s.* or 118*l.* 6*s.* 2*d.*

Queſt 6. If $3\frac{1}{4}$ Yards of Velvet coſt $3\frac{5}{8}$*l.* how much will $10\frac{1}{2}$ Yards coſt at that Rate?

Anſwer $11\frac{37}{52}$*l.*

Queſt. 7 If 3 Yards of Broad-cloth coſt $2\frac{4}{5}$*l.* what will $14\frac{3}{7}$ Yards coſt?

Anſwer 13*l.* 9*s.* 4*d.*

In working the laſt Queſtion and the four next, obſerve the 4th Rule of the Chapter foregoing.

Queſt. 8. If 14 lb of Pepper coſt 14*s.* $6\frac{2}{3}$*d.* I demand the Price of $73\frac{3}{4}$ lb?

Anſwer 3*l.* 16*s.* $7\frac{43}{56}$*d.*

Queſt. 9. If 1 lb of Cochineel coſt 1*l.* 5*s.* what will $36\frac{7}{10}$ lb coſt?

Anſwer 45*l.* 17*s.* 6*d.*

Queſt. 10 If 1 Yard of Broad-cloth coſt $15\frac{5}{8}$*s.* what will 4 Pieces, each containing $27\frac{3}{7}$ Yards coſt at that Rate?

Anſwer 85*l.* 14*s* $3\frac{3}{7}$*d.*.

Queſt. 11. A Mercer bought $3\frac{1}{2}$ Pieces of Silk, each Piece contained $24\frac{2}{3}$ Ells, at 6*s.* $0\frac{3}{4}$*d.* *per* Ell, I demand the Value of $3\frac{1}{2}$ Pieces at that Rate?

Anſwer 26*l.* 3*s.* $4\frac{3}{4}$*d.*

If

In resolving the four next Questions, observe the 8th Rule of Chap. 19.

Quest. 12. If $\frac{2}{7}$ of an Ounce of Silver cost 2*s.* I demand the Price of $11\frac{2}{3}$ at that Rate?

Answer 35*l.*

Quest. 13. If $6\frac{3}{7}$ lb of Gold is worth 205*l.* 14*s.* $3\frac{3}{4}$*d.* *Sterling*, what is a Grain worth at that Rate?

Answer $1\frac{1}{3}$*d.*

Quest. 14. If $\frac{3}{4}$ Yards of Silk is worth $\frac{3}{4}$ of $\frac{5}{8}$*l.* what is the Price of $15\frac{2}{5}$ Ells Flemish?

Answer 9*l.* 12*s.* 6*d.*

Quest. 15. If $\frac{2}{3}$ of $\frac{3}{4}$ of a Pound of Cloves cost 6*s.* $2\frac{2}{7}$*d.* what cost the C. weight at that Rate?

Answer 69*l.* 6*s.* 8*d.*

Note, That when the Answer to the Questions in this and the next Chapter are given in Fractions, they are given in their lowest Terms.

CHAP. XXV.

The Rule of Three Inverse in Fractions.

1. IT hath been already taught (in the 3d Rule of the 11th Chapter, how to discover when the 4th proportional Number (to the 3 given Numbers) is to be found out by a *Rule of Three Direct*, and when by a *Rule of Three Inverse*, to which Rule the Learner is now referred.

2. When (in Fractions) you find a Question to be resolv'd by the *Rule of Three Inverse, viz.* when the third Term is the Divisor, then having reduced the Terms exactly (according to the Rules in Chap. 24.) multiply the Numerators of the third Fraction into the Denominators of the second and first Fractions, and the Product is a new Denominator; then multiply the Denominator of the third Fraction into the Numerators of the second and first Fractions, and the Product is a new Numerator, which new Fraction thus found is the Answer to the Question.

Quest. 1. If $\frac{3}{4}$ of a Yard of Cloth, that is two Yards wide, will make a Garment, how much of any other Drapery that is $\frac{3}{5}$ of a Yard wide will make the same Garment

Answer $2\frac{1}{2}$ Yards.

Quest. 2. I lent my Friend 46*l.* for $\frac{4}{5}$ of a Year, how much ought he to lend me for $\frac{7}{12}$ Parts of a Year?

Answer $63\frac{3}{35}$ *l.*

Quest.

Quest. 3. If $\frac{2}{3}$ of a Yard of Cloth that is $2\frac{1}{3}$ Yards wide will make any Garment, what Breadth is that Cloth when $1\frac{3}{4}$ Yard will make the same Garment?

Answer $\frac{56}{63}$ or $\frac{8}{9}$ of a Yard wide?

Quest. 5. How many Inches in Length of a Board that is 9 Inches broad will make a Foot square?

Answer 16 Inches in Length.

Quest. 5. If when the Bushel of Wheat cost $4\frac{3}{4}$s., the Penny Loaf weighed $10\frac{2}{5}$ Ounces, what will it weigh when the Bushel cost $8\frac{8}{18}$s.?

Answer $5\frac{184}{284}$ Ounces.

Quest. 6. If 17 Men can mow $24\frac{1}{2}$ Acres in $10\frac{2}{3}$ Days, in how many Days will 6 Men do the same?

Answer, in $21\frac{1}{3}$ Days.

CHAP. XXVI.

Rules of Practice.

1. IN the single Rule of Three, when the first of the three Numbers in the Question (after they are disposed according to the 6th Rule of Chap. 10.) happeneth to be an Unit (or 1.) that Question many times may be resolved far more speedily than by the Rule of Three, which kind of Operation is commonly called *Practice*; and indeed it is of excellent Use among Merchants, Tradesmen and others, by reason of its speediness in finding a Resolution to such kind of Questions.

2. The chiefest Questions resolvable by these brief Rules, may be comprehended under the three general Heads or Cases following, *viz.*

When the given Price of the Integer consists
1. Of Farthings under 4.
2 Of Pence under 12.
3. Of Pence and Farthings.
4. Of Shillings under 20.
5. Of Shillings, Pence and Farthings.
6. Of Pounds.
7. Of Pounds, Shillings, Pence & Farthings.

It would be very convenient for the practical Arithmetician to have by Heart the several Products of the nine Digits multiplied by 12, for his speedy reducing Pence into Shillings, and Shillings into Pence, which he may gain by the following Table.

12 Times	1	is	12	
	2		24	
	3		36	
	4		48	
	5		60	
	6		72	
	7		84	
	8		96	
	9		108	

3. Shillings are practically reduced into Pounds thus, *viz.* cut off the Figure ſtanding in the Place of Units with a Daſh of the Pen, and note it for Shillings, then draw a Line under the given Number, and take half the remaining Figures (after the firſt is cut off) and ſet them under the Line, and they are ſo many Pounds; but if the laſt Figure is odd, then take the leſſer half, and add 10 to the Figure ſo cut off (as before) for Shillings; as if I were to reduce 43658 Shillings into Pounds, firſt I cut off the laſt Figure (8) for Shillings, then I take half of the remaining Figures (4365) thus, half of 4 is 2, which I put under the Line, then half of 3 is 1, and becauſe 3 is an odd Number, I make the next Figure 6 to be 16, and I go on, ſaying, half of 16 is 8, then half of 5 is 2, which is the laſt Figure, wherefore, becauſe 5 is an odd Number, I add 10 to the 8 I cut off, and it makes 18*s.* ſo that I find it to be 2182*l.* 18*s.* as *per* Margent.

4365|8	
l.	*s.*
2182	18

4. It is likewiſe convenient that the Learner be acquainted with the practical Tables following, the firſt containing the aliquot or even Parts of a Shilling, the ſecond containing the even Parts of a Pound.

The even Part of a Shilling		is	
	6		$\frac{1}{2}$
	4		$\frac{1}{3}$
	[illegible]		$\frac{1}{4}$
	[illegible]		$\frac{1}{6}$
	1 $\frac{1}{2}$		$\frac{1}{8}$
	1		$\frac{1}{12}$

The even Parts of a Pound.			is	*l.*
	10	00		$\frac{1}{2}$
	6	08		$\frac{1}{3}$
	5	00		$\frac{1}{4}$
	4	00		$\frac{1}{5}$
	3	04		$\frac{1}{6}$
	2	06		$\frac{1}{8}$
	2	00		$\frac{1}{10}$
	1	08		$\frac{1}{12}$
	1	00		$\frac{1}{20}$

Caſe.

5. When the Price of an Integer is a Farthing, then take the 6th Part of the given Number, which will be ſo many Three-half-pences, and if any Thing remain it is Farthings, by the 7th Rule of Chap. 9. then conſider, that Three-

Three half pence is $\frac{1}{8}$ of a Shilling, wherefore take the 8th Part of them for Shillings, and if any Thing remain, they are so many Three half-pences, which reduce into Pounds by the 3d Rule foregoing.

Example.

What comes 67486℔ to at a Farthing *per* ℔? First, I take $\frac{1}{6}$ of 67486, and it is 11247 Three-half pences, and 4 Farthings, or 1 Penny; then $\frac{1}{8}$ of 11247 is 1405*s.* and 7 remains, which is 7 Three-half-pences, or $10\frac{1}{2}$*d.* which with the 4 Farthings before, make $11\frac{1}{2}$*d.* and 1405*s.* which by the 3d Rule is 70*l.* 5*s.* in all 70*l.* 5*s.* $11\frac{1}{2}$*d.* for the Answer. See the Work following.

$\frac{1}{6}$	67486 at $\frac{1}{4}$ *per* ℔		
			d.
$\frac{1}{8}$	11247		1
$\frac{1}{20}$	140|5		$10\frac{1}{2}$
	l.	*s.*	*d.*
	70	5	$11\frac{1}{2}$ *facit.*

Other Examples follow.

$\frac{1}{6}$	8575℔ at 1*qr.*		
$\frac{1}{8}$	1429		2*qrs.*
$\frac{1}{20}$	17|8		8*d.*
	l.	*s*	*d.*
	8	8	8 *facit.*

$\frac{1}{6}$	6380 ℔ at 1*qr.*		
$\frac{1}{8}$	1063		2*qrs.*
$\frac{1}{20}$	13|2		11*d.*
	l.	*s.*	*d.*
	6	12	11 *facit.*

6. When the Price of the Integer is two Farthings, then take the third Part of the given Number for so many Three-half-pences, and the Remainder, if any, is Half-pence, then take the eighth Part of that for Shillings, as before, *&c.*

Example.

$\frac{1}{3}$	7368℔ at 2*qrs*		
$\frac{1}{8}$	2456		
$\frac{1}{20}$	34|7		
	l.	*s.*	
	15	7	

$\frac{1}{3}$	8347℔ at 2*qrs.*		
$\frac{1}{8}$	2782		2*qrs.*
$\frac{1}{20}$	34|7		9*d.* $\frac{1}{2}$
	l	*s.*	*d.*
	17	7	$9\frac{1}{2}$ *facit.*

7. When the Price of the Integer is 3 Farthings, then take half the given Number for Three-half-pence, and if any Thing remain it is 3 Farthings; then take the 8th for Shillings, as before, *&c.*

½	4736 lb at 3*qrs.*	½	5425 lb at 3*qrs.*
⅛	2368	⅛	2712 6*d.*
1/20	29|6	1/20	33|9 3*qrs.*
	l. *s.* *d.*		*l.* *s.* *d.* *qrs.*
	14 16 *facit*		16 19 0 3 *facit*

Case 2.

8. When the given Price of the Integer is a part or parts of a Shilling, (*viz.* Pence) divide the given Number of Integers (whose Value is sought) by the Denominator of the Fraction, representing the even part, and the Quote is Shillings (always minding the 7th Rule of the 9th Chapter) and those Shillings may be reduced into Pounds by the 3d Rule of this Chapter. *Example.* Let it be required to find the Value of 438*l.* at 3*d. per l.* I consider 3*d*, is ¼ of a Shilling, and 438*l.* will cost so many 3 Pences, wherefore I divide 438 by 4, the Denominator of ¼, and the Quote is 109 Shillings, and 2 remains, which is two 3*d.* or 6*d* the whole Value is 5*l.* 9*s.* 6*d.* as by the following Work appeareth.

¼	338 *l.* at 3 *d.*
1/20	10|9 ——6

l. *s.* *d.*
Facit 5 9 6

More Examples follow.

	l. *d.*		*l.* *d.*
½	3574 at 6 *per* l.	1/6	5316 at 2 *per* l.
1/20	17|8 7	1/20	38|6
	89*l* 7*s. facit*		44*l.* 6*s. facit*
	l. *d*		*l.* *d.*
⅓	438 at 4 *per l.*	⅛	6389 at 1½ *per* l.
1/20	14|0	1/20	79|8 7*d.* ½
	7*l.* 6*s* *facit*		39*l.* 18*s.* 7*d.* ½
	l *d.*		*l.* *d*
¼	879 at 3 *per l.*	1/12	818 at 1 *per* l.
1/20	219 9*d.*	1/20	6|8 2
	10*l.* 19*s.* 9*d*		3*l.* 8*s.* 2*d. facit*

If the Learner is minded to try the Fruitfulness of his Genius, he may frame as many Examples as he thinks fit, and work them as before

9. If the Price of the Integer be Pence under 12, and yet not an even Part, then it may be divided into even Parts, and so the Parts of the given Numbers taken accordingly and added together; as if it were 5*d.* which is 3*d.* and

and 2*d* *viz.* $\frac{1}{4}$ and $\frac{1}{6}$ of a Shilling, first take $\frac{1}{4}$ of the given Number, and then $\frac{1}{6}$ thereof, and add them together, and their Sum is the Anſwer in Shillings: ſtill obſerving Rule 7 of Chap. 9. for the Remainder, (if any be) then bring the Shillings into Pounds, by the 3d Rule foregoing. Likewiſe 7*d.* is $\frac{1}{3}$ and $\frac{1}{4}$, ſo 9*d.* is $\frac{1}{2}$ and $\frac{1}{4}$, and 10*d.* is $\frac{1}{2}$ and $\frac{1}{3}$, and 11*d.* is $\frac{1}{3}$ and $\frac{1}{3}$ and $\frac{1}{4}$ of a Shilling; or elſe many Times your Work may be ſhortened thus *viz.* when the ſaid given Price is to be divided into even Parts of a Shilling, or of a Pound, after you have taken the firſt even Part, the other may be an even Part of that Part, as in the next Example, where is given 439*l.* at 5*d. per l.* now I may divide it thus, *viz.* into 4*d.* and 1*d.* and 4*d.* being $\frac{1}{3}$ of a Shilling, and 1*d.* being $\frac{1}{4}$ of 4*d.* I firſt take $\frac{1}{3}$ of 439*l.* and it gives 146*s.* 4*d.* and for the 1*d.* I take $\frac{1}{4}$ of 146*s.* 4*d.* which is 36*s.* 7*d.* which in all comes to 9*l.* 2*s.* 11*d.* Examples follow.

	l.	*d.*
	439	at 5 *per l.*
$\frac{1}{3}$	146	4
$\frac{1}{4}$	36	7
	18|2	11
	9*l.* 2*s.* 11*d.* *Facit*	

	yds.	*d.*
	417	at 9 *per yd.*
$\frac{1}{2}$	208	6
$\frac{1}{2}$	104	3
$\frac{1}{10}$	31|2	9
	15*l.* 12*s.* 9*d.* *Facit*	

	Ells	*d.*
	587	at 7*d. per* Ell
$\frac{1}{3}$	195	8
$\frac{1}{4}$	146	9
	34|2	5
	17*l* 2*s.* 5*d.* *Facit*	

	Ells	*d.*
	386	at 10
$\frac{1}{2}$	193	
$\frac{1}{3}$	128	8
	32|1	8
	16*l.* 1*s.* 8. *Facit*	

	yds.	*d.*
	836	at 8 *per yd.*
$\frac{1}{3}$	278	8
$\frac{1}{3}$	278	8
	55|7	4
	27*l.* 17*s.* 4*d.* *Facit*	

	l.	*d.*
	534	at 11
$\frac{1}{3}$	178	
$\frac{1}{3}$	178	
$\frac{1}{4}$	133	6
	48|9	6
	24*l.* 9*s.* 6*d.* *Facit*	

10. When the Price of the Integer is Pence and Farthings, if it make an even Part of a Shilling, work as before; but if they are uneven, as Penny Farthing, Penny three Farthings, 2*d.* 1*qr.* or 2*d.* 3*qrs.* 3*d.* 3*qrs.* or the like, then firſt work for ſome even Part, and then conſider what

part the rest is of that even part, and divide that Quotient thereby, then add them together, and reduce them to Pounds as before. *Example.* 3470lb at 1*d.* 1*qr.* *per* lb; first I work for the Penny by dividing 3470lb by 12, for 1*d.* is $\frac{1}{12}$ of a Shilling, and the Quote is 289*s.* 2*d.* then I conceive that one Farthing is the $\frac{1}{4}$ of a Penny, and the Value at one Farthing will be $\frac{1}{4}$ of the Value at a Penny, and therefore I take $\frac{1}{4}$ of 289*s.* 2*d.* which is 72*s.* 3*d.* 2*qrs.* and add them together, and they are 18*l.* 1*s.* 5*d.* 2*qrs.* as by the Margent.

	l.	*s.*	*d.*	*qrs.*
$\frac{1}{12}$	3470 at		1	1
$\frac{1}{4}$	289		2	
	72		3	2
$\frac{1}{20}$	36|1		5	2
	l.	*s.*	*d.*	*qrs.*
	18	1	5	2

	l.	*d.*
$\frac{1}{12}$	4360 at $1\frac{1}{4}$	
$\frac{1}{4}$	363	4
	90	10
	454	2
	22*l.* 14*s.* 2*d.* *facit*	

	yds.	*d.*
$\frac{1}{8}$	573 at $1\frac{3}{4}$	
$\frac{1}{6}$	71	$7\frac{1}{2}$*d.*
	11	$11\frac{1}{4}$
	83	6
	4*l.* 3*s.* $6\frac{3}{4}$*d.* *facit*	

	485*l.* at $2\frac{1}{4}$*d.*	
$\frac{1}{8}$	80	10*d.*
	10	$1\frac{1}{4}$
	90	$11\frac{1}{4}$
	4*l.* 10*s.* $11\frac{1}{4}$*d.* *facit*	

$\frac{1}{2}$	520 *yds.* at $7\frac{1}{2}$	
$\frac{1}{4}$	260	
	65	
$\frac{1}{20}$	32|5	
	16*l.* 5*s.* *facit*	

$\frac{1}{6}$	654*l.* at $2\frac{1}{2}$*d.*	
$\frac{1}{4}$	109	
	27	3*d.*
	136	
	6*l.* 16*s.* 3*d.* *facit*	

$\frac{1}{2}$	137 *yds* at $10\frac{1}{2}$*d.*	
$\frac{1}{2}$	68	6*d.*
$\frac{1}{2}$	34	3
	17	$1\frac{1}{2}$
$\frac{1}{20}$	11|9	$10\frac{1}{2}$*d.*
	5*l.* 19*s.* $10\frac{1}{2}$*d.* *facit*	

Case 4.

11. When the Price of the Integer is 2*s.* then cut off the Figure in the Place of Units of the given Number, and double it for Shillings, and the Figures on the other hand are Pounds. *Example.* 436 Yards at 2*s* *per* Yard: cut off the last Figure 6, and double it, it makes 12*s.* and the two other Figures, *viz.* 43. are so many Pounds; so that their Value is 43*l.* 12*s* as *per* Margent.

436
43*l.* 12*s.*

12. Hence it is evident, that when the given Price of an Integer is an even Number of Shillings, then if you take half

half of that (even Number of Shillings, and multiply the given Number of Integers thereby, doubling the first Figure of the Product and setting it apart for Shillings, the rest of the Product will be Pounds, which Pounds and Shillings are the Value sought. *Example.* What cost 536 Yards at 8*s. per* Yard? To resolve which, I take half of 8*s* (the Price of a Yard) which is 4, and multiply 536 thereby, saying, 4 times 6 is 24, then I double the first Figure 4 makes 8 for Shillings, and carry 2 to the next Product, *&c.* I find the rest of the Product to be 214, which I note for Pounds; so that the Value of 536 Yards at 8*s. per* Yard, is 214*l.* 8*s.* as by the Margent. Other Examples of the same Kind may be wrought after the same manner.

536 *yds.* at 8*s.*
4
214*l.* 8*s.*

56 *yds* at 6*s. per* yard
16*l.* 16*s.* *facit*

123 *yds* at 4*s. per* yard
24*l.* 12*s.* *facit*

48 *Ells* at 8*s. per* Ell
19*l.* 4*s.* *facit*

84 *yds* 10*s. per* yard
42*l.* *facit*

420 *yds* at 12*s. per* yd.
252*l.* *facit.*

326 *yds* at 14*s. per* yd.
228*l.* 4*s.* *facit*

48 *yds* at 16*s. per* yard
38*l.* 8*s.* *facit*

52 *yds* at 18*s. per* yard
46*l.* 16*s.* *facit*

13. If the given Price of the Integer is an odd Number of Shillings, then work first for the even Number of Shillings, by the last Rule, and for the odd Shilling take $\frac{1}{20}$ of the given Number of Integers according to the 3d Rule of this Chapter, and add them together, and you you have your Desire. Examples follow.

Yds. *s.*
422 at 3 *per* Yard

l.	*s.*
42	4
21	2
63	6 *facit*

Ells *s.*
516 at 7 *per* Ell

l.	*s.*
154	16
25	16
180	12 *facit*

Ells *s.*
431 at 13.

l	*s.*
258	12
21	11
280	03 *facit*

Ells *s.*
324 at 17 *per* Ell

l.	*s.*
259	04
16	04
275	08 *facit*

14. Except when the given Price of the Integer is 5*s.* for then it is sooner answered by taking $\frac{1}{4}$ of the given Number whose Value is sought, as in the following Example.

	Yds.	*s.*			*Ells*	*s.*
$\frac{1}{4}$	436 at	5 *per* Yard		$\frac{1}{4}$	206 at	5 *per* Ell
	109*l* *facit*				51*l.* 10*s.* *facit*	

Case 5.

15. When the given Price of an Integer is Shillings and Pence, *&c.* making an even part of a Pound, then divide the given Number of Integers, whose Value you seek, by the Denominator of that Fraction representing that even part. As for Example. What is the Price of 384 Yards at 6*s.* 8*d* *per* Yard? Here I consider that 6*s.* 8*d.* is $\frac{1}{3}$ of a Pound, wherefore divide 384 by 3, and the Quote is the Answer, *viz* 128*l.* so that 384 Yards at 6*s* 8*d.* *per* Yard, amounts to 128*l.* as *per* Margent, still observing the 7th Rule of the 9th Chapter.

$\frac{1}{3}$	384
	128*l.* *fa.*

More Examples follow.

$\frac{1}{3}$	438 *Ells* at 6*s.* 8*d.*	$\frac{1}{8}$	443 *Yards* at 2*s.* 6*d.*
	146*l* *facit*		55*l.* 7*s* 6*d.* *facit.*
$\frac{1}{6}$	525 at 3*s.* 4*d.*	$\frac{1}{12}$	726 *Yards* at 1*s.* 8*d.*
	87*l.* 10*s* *facit*		60*l.* 10*s.* *facit.*

16. When the given Value of the Integer is Shillings and Pence, and not an even Part of a Pound, yet many times it may be divided into Parts, (*viz.* 6*s.* 6*d.* is 4*s.* and 2*s.* 6*d.*) for the 4*s.* Work according to the 12th Rule foregoing, and for the 2*s.* 6*d.* take the eighth Part of the given Number, and add them together, then their Sum is the Value required.

So 8*s.* 6*d.* will be divided into 6*s.* and 2*s.* 6*d.* and the Price of the given Number may be found out as before, *&c.* Examples follow.

	yds.	*s.*	*d.*		*Ells*	*s.*	*d.*
	386 at 8		8	*s.*	427 at 8		6
$\frac{1}{3}$	128*l.*	13	4	6	128*l*	2	0
$\frac{1}{10}$	38	12	0	$\frac{1}{8}$	53	7	6
	167*l.* 5*s.* 4*d.* *Facit*				181*l.* 9*s.* 6*d.* *Facit*		

Ells

	Ells	*s.*	*d.*
s	540 at	5	4
2	54	0	
$\frac{1}{6}$	90	0	
	144 *l. Facit*		

	yds.	*s.*	*d.*
s.	386 at	14	8
8	154 *l.*	8	0
$\frac{1}{3}$	128	13	4
	283 *l.* 1 *s.* 4 *d* *Facit*		

17. When the given Price of an Integer is Shillings and Pence, and you cannot readily divide them according to the laſt Rule, then multiply the given Number whoſe Value you ſeek, by the Number of Shillings in the Price of the Integer, and then for the Pence work by the 8th Rule foregoing; then add the Numbers together, and their Sum is their Value ſought in Shillings; as for Example. What is the Value of 392 Yards at 6*s.* 9*d. per* Yard. Here 6*s.* 9*d.* cannot be made an even Part, nor indeed can it be divided into even Parts of a Pound; whereſore I multiply the given Number of Yards 392 by 6 for the 6*s.* the Product is 2352*s.* then for the 9*d.* I divide it into 6*d.* and 3*d.* and work for them by the 8th Rule foregoing, and at laſt add the Shillings together, they make 2646*s.* and by the third they are reduced to 132*l.* 6*s.* the Value of 392 Yards at 6*s.* 9*d. per* Yard. See the Work.

	—392 *yds.* at 6*s.* 9*d.*
	2352
$\frac{1}{2}$	196
$\frac{1}{4}$	98
	2646
	132 *l.* 6 *s.* *Facit*

Other Examples follow.

		l.	*s.*	*d.*
		480 at	4	10
	s.	4		
d	4	1920		
6	$\frac{1}{2}$	240		
4	$\frac{1}{3}$	160		
		2320		
		116 *l. facit*		

	Ells	*s*	*d.*
	732 at	12	7
	12		
12	8784		
4 $\frac{1}{3}$	244		
3 $\frac{1}{4}$	183		
	9211		
	460 *l.* 11 *s.* *facit*		

In like manner may Variety of other Examples be wrought.

18. When the given Price of the Integer is Shillings, Pence, and Farthings, then multiply the given Number of Integers, by the Number of Shillings contained in the Value of the Integer, and for the Pence and Farthings follow the 10th Rule of this Chapter.

Example.

	Ells	*s.*	*d*
s	438 at	8	$6\frac{3}{4}$
8	3504		
$\frac{1}{2}$	219		
$\frac{1}{8}$	27		$4\frac{1}{2}d.$
	375|0		$4\frac{1}{2}$
	Fac. 187*l.* 10*s.* $4\frac{1}{2}d.$		

	Ells	*s.*	*d.*
s.	136 at	9	$2\frac{1}{2}$
9	1224	0	
$\frac{1}{3}$	22	8	
$\frac{1}{4}$	5	8	
	125|2	4	
	Fac. 62*l.* 12*s.* 4*d.*		

	Ells	*s.*	*d.*
	370 at	14	$2\frac{3}{4}$
	1480		
s.	370		
14	5180		*d.*
$\frac{1}{6}$	61		8
$\frac{1}{4}$	15		5
$\frac{1}{2}$	7		$8\frac{1}{2}$
	526|4		$9\frac{1}{2}$
	Fac 263*l.* 4*s.* 9*d.*$\frac{1}{2}$		

	Ells	*s.*	*d.*
	431 at	2	$4\frac{1}{2}$
2	862		
$\frac{1}{4}$	107		9*d.*
$\frac{1}{8}$	53		$10\frac{1}{2}$
	102|3		$7\frac{1}{2}$
	Fac. 51*l.* 3*s.* $7\frac{1}{2}d.$		

Case 6.

19. When the given Value of the Integer is Pounds, then multiply the Number of Integers, whose Value is sought, by the Price of the Integer, and the Product is the Answer in Pounds.

Examples.

C. *l.*
42 at 2 *per C.*
84*l. facit*

C. *l.*
13 at 8 *per C.*
104*l. facit*

C. *l.*
30 at 3 *per C.*
90*l. facit*

C. *l.*
48 at 12 *per C.*
576*l. facit*

Case 7.

20. If the Price of the Integer is Pounds and Shillings, then for the Pounds work as in the last Rule, and for the Shillings as in the 12th and 13th Rules foregoing; then add the Numbers produced from them both, and the Sum is the Value sought.

Examples.

Examples.

	C.	l.	s.
	46 at	2	4
2l.	92	s.	
4s	9	4	
	101	4	

	Gross	l.	s.
	58 at	3	7
3l.	174	s.	
6s	17	8	
1s	2	18	
	194l.	6s. *facit*	

	Gross	l.	s.
	82 at	4	10
4l	328		
10s.	41		
	369l. *facit*		

	Gross	l.	s.
	26 at	3	15
3l.	78		
14s.	18	4	
1s.	1	6	
	97l.	10s. *facit*	

21. When the given Price of an Integer consists of Pounds, Shillings, Pence and Farthings, then work for the Shillings, Pence and Farthings first, according to the 18th Rule of this Chapter, and find the total Value of the given Number, as if there were no Pounds, then work with the Pounds, according to the 19th Rule of this Chapter, and add the Numbers thus found, and their Sum is the total Value required. *Examples of this Rule follow.*

	C.	l.	s.	d.
	213 at	1	13	$4\frac{1}{2}$
	639			
	213			
13s.	2769		d.	
3d	53		3	
$1\frac{1}{2}d.$	26		$7\frac{1}{2}$	
	284|8		$10\frac{1}{2}$	
	142l.	08s.	$10\frac{1}{2}d.$	
1l.	213			
	355l.	08s.	$10\frac{1}{2}d.$ *facit*	

	Gross	l.	s.	d.
	416 at	2	9	$3\frac{1}{4}$
9s.	3744			
3d.	104			
$\frac{1}{4}d.$	26			
	387|4			
2l.	193l.	14s.		
	832			
	1025l.	14s. *facit*		

C.	l.	s.	d.	
37 at	3	8	$10\frac{1}{2}$	
296	d.			8 s.
18	6			6 d.
9	3			3 d.
4	$7\frac{1}{2}$			$1\frac{1}{2}d.$
2|8	$4\frac{1}{2}$			
16l.	8s.	$4\frac{1}{2}d.$		
111				3l.
127l.	8s	$4\frac{1}{2}d.$ *facit.*		

Gross	l.	s.	d.	
48 at	3	15	$11\frac{1}{2}$	
240				
48				
720				15s.
24				6d.
16				4d.
6				$1\frac{1}{2}d.$
76|6				
38	6			
144				3l.
182l.	6s. *facit*			

22. When

22. When there is given the Value of an Integer, and it is required to know the Value of many such Integers together, with $\frac{1}{2}$ or $\frac{1}{4}$ or $\frac{3}{4}$ of an Integer, then first (by the former Rules) find out the Value of the given Number of Integers, and then for $\frac{1}{2}$ of an Integer, take $\frac{1}{2}$ of the given value of the Integer, or for $\frac{1}{4}$ take $\frac{1}{4}$ of the given value of the Integer; and for $\frac{3}{4}$ first take the half of the given value, and then half of that half, setting each Part under the Precedent, then adding them together, their Sum will be the required value of the Integers and their Parts.

Example.

What is the value of 116$\frac{1}{2}$ Yards, at 4*s.* 6*d. per* Yard To give an Answer; first, I work for the value of 116 Yards, by the 15th Rule foregoing, and then for the half Yard, I take half of 4*s.* 6*d.* which is 2*s.* 3*d.* and add to the rest found as before, then is that Sum the total value of 116$\frac{1}{2}$ Yards at 4*s.* 6*d. per* Yard, which I find to amount to 26*l.* 4*s.* 3*d.* as by the Work in the Margent. And all other Examples of this Kind are wrought the same way.

yds.	*s.*	*d.*	
116$\frac{1}{2}$ at	4	6	
11*l.*	12*s.*		2*s.*
14*l.*	10*s.*		2*s.* 6*d.*
	2	3	$\frac{1}{2}$ *Yards*
26	4	3	*facit*

Other Examples follow.

224$\frac{1}{4}$ *yds.* at 4*s.* 10*d.*	
1296	4*s.*
162	6*d* $\frac{1}{2}$
108	4*d.* $\frac{1}{3}$
1 2$\frac{1}{2}$*d.*	$\frac{1}{4}$ *yd.*
156 | 7*s.* 2$\frac{1}{2}$*d.*	
78*l.* 7*s.* 2$\frac{1}{2}$*d.* *facit*	

720$\frac{1}{2}$ *yds.* at 6*s.* 8*d.*
240*l.* 3*s.* 4*d.* *facit*

228$\frac{1}{2}$ *Ells* at 12*s* 11*d*	
2736	12*s.*
76	4*d.* $\frac{1}{3}$
76	4*d.* $\frac{1}{3}$
57	3*d.* $\frac{1}{4}$
6 5$\frac{1}{2}$*d.*	$\frac{1}{2}$ *Ell.*
3 2$\frac{3}{4}$*d.*	$\frac{1}{4}$ *Ell.*
295 | 4 8$\frac{1}{4}$*d.*	
147*l.* 14*s.* 8$\frac{1}{4}$*d.* *facit*	

C.	*qrs.*	*l.*	*l.*	*s.*	*C.*
28	3	14 at	1	10	
28*l.*				1*l.*	
14				10*s.* $\frac{1}{2}$	
	1 *s.*			$\frac{1}{2}$ *C.*	
		7*s.* 6*d.*		$\frac{1}{4}$ *C.*	
		3*s.* 9*d.*		14*l.*	
43*l.*		6*s.* 3*d.* *facit*			

Many more Questions may be stated, and several other Rules of Practice may be shewn, according to the Methods of

of diverse Authors, but what have been delivered here are sufficient for the practical Arithmetician in all Cases whatsoever.

CHAP. XVII.

Barter.

1. BARTER is a Rule among Merchants, which (in the Exchange of one Commodity for another) informs them so to proportion their Rates as that neither may sustain Loss.

2 To resolve Questions in *Barter*, will not to be difficult to him that is acquainted with the *Golden Rule*, or *Rule of Three*, it being altogether used in resolving such Questions.

Quest 1. Two Merchants (*viz. A* and *B*) barter, *A* hath 13*C*. 3*qrs*. 14lb of Pepper, at 2*l*. 16*s* *per C*. and *B* hath Cotton at 9*d*. *per* lb I demand how much Cotton *B* must give *A* for his Pepper?

Answer 9*C*. 1*qr*.

First find by the *Rule of Three*, or the Rules of *Practice* foregoing, how much the Pepper is worth, saying, if 1*C*. cost 2*l*. 16*s*. what will 13*C*. 3*qrs*. 14 lb cost?

Answer 38*l*. 17*s*.

Secondly, by the *Rule of Three*, say, if 9*d*. buy 1lb of Cotton, how much will 38*l*. 17*s* buy?

Answer 9¼*C*. and so much Cotton must *B* give to *A* for 13*C*. 3*qrs*. 14lb of Pepper, at 2*l*. 16*s*. *per C*. when the Cotton is worth 9*d*. *per* lb

Quest. 2. *A* and *B* barter, *A* hath 120 Yards of Broadcloth worth 6*s*. *per* Yard, but in the Barter he will have 8*s*. *per* Yard; *B* hath Shalloon worth 4*s*. *per* Yard. Now I demand how many Yards of Shalloon *B* must give *A* for his Broadcloth, making his Gain in Barter equal to that of *A*?

Answer 180 Yards of Shalloon.

First (as in the last Question) find out how *B* ought to sell his Shalloon in Barter, *viz*. say, if 6*s*. require 8*s* what will 4*s*. require?

Answer 5*s*. 4*d*.

Thus you see that *B* must sell his Shalloon in Barter at 5*s*. 4*d*. if *A* sell his Broadcloth at 8*s*. *per* Yard.

It remaineth now to find out how much Shalloon *B* must give for 120 Yards of Broadcloth; which resolved after the Method in the first Question of this Chapter, is found to

be 180, and so many Yards of Shalloon must *B* give *A* for the 125 Yards of Broad-cloth.

Quest. 3. *A* and *B* bartered, *A* had 14*C.* of Sugar, worth 6*d. per* ℔, for which *B* gave him 1*C.* 3*qrs.* of Cinnamon; I demand how *B* rated his Cinnamon *per* ℔?

Answer 4*s. per* ℔.

Quest. 4. *A* and *B* barter, *A* hath 4 Tun of Brandy, worth 37*l.* 16*s.* ready Money, but in Barter he hath 50*l.* 8*s. per* Tun, and *B* giveth 21*C.* 2*qrs.* 11$\frac{1}{2}$℔ of Ginger for the 4 Tun of Brandy; I desire to know how much *B* sold his Ginger for in Barter *per C.* and how much it is worth in ready Money?

Answer for 9*l.* 6*s.* 8*d.* in Barter, and it is worth 7*l. per C.* in ready Money.

Quest. 5. *A* and *B* barter, *A* hath 320 Dozen of Candles of 4*s.* 6*d. per* Dozen, for which *B* giveth him 30*l.* in Money, and the rest in Cotton at 8*d. per* ℔; I demand how much Cotton he must give him more than the 30*l.*

Answer 11*C.* 1*qr.*

CHAP. XXVIII.

Questions in Loss and Gain.

Q. 1. A Merchant bought 436 Yards of Broadcloth for 8*s.* 6*d. per* Yard, and selleth it again at 10*s.* 4*d. per* Yard; now I desire to know how much he gained in the Sale of the 436 Yards?

Answer 39*l.* 19*s.* 4*d.*

First, find out by the *Rule of Three,* or by *Practice,* how much the Cloth cost him at 8*s.* 6*d. per* Yard, which I find to be 185*l.* 6*s.* then by the same Rule find out how much he sold it for, *viz.* 225*l.* 5*s.* 4*d.* then subtract 185*l.* 6*s.* which it cost him, from 225*l.* 5*s.* 4*d.* which he sold it for, and there remaineth 39*l.* 19*s.* 4*d.* for his Gain in the Sale thereof.

Otherwise, it may sooner be resolved thus; first find out how much he gained *per* Yard, *viz.* subtract 8*s.* 6*d.* which he gave *per* Yard, from 10*s.* 4*d.* which he sold it for *per* Yard, the Remainder is 1*s.* 10*d.* for his Gain *per* Yard. Then say,

If 1 Yard gain 1*s.* 10*d.* what will 436 Yards gain? The Answer, by *Practice* or the *Rule of Three,* is 39*l.* 19*s.* 4*d.* as was found before.

Quest.

Quest. 2. A Draper bought 124 Yards of Holland Cloth for which he gave 31*l.* I desire to know how he must sell it *per* Yard to gain 10*l.* 6*s.* 8*d.* in the whole Sale of 124 Yards?

Answer at 6*s.* 8*d.* *per* Yard.

Add the Price which it cost him (*viz.* 31*l.*) to his intended Gain (*viz.* 10*l.* 6*s.* 8*d.*) the Sum is 41*l.* 6*s* 8*d.* Then say,

If 124 Yards require 41*l.* 6*s.* 8*d.* what will 1 Yard require? By the *Rule of Three* I find the Answer to be 6*s.* 8*d.*

Quest. 3 A Grocer bought 3*C.* 1*qr.* 14℔ of Cloves, which cost him 2*s.* 4*d.* *per* ℔ and sold them for 52*l.* 14*s.* I desire to know how much he gained in the whole?

Answer 8*l.* 12*s.*

Quest. 4. A Draper bought 86 Kerseys for 129*l.* I demand how he must sell them *per* Piece to gain 15*l.* in laying out 100*l.* at that Rate?

Answer 1*l.* 14*s.* 6*d.* *per* Piece; for,

As 100*l.* is to 115*l.* so is 129*l.* to 148*l.* 7*s.*

So that, by the Proportion above, I have found how much he must receive for the 86 Kerseys, to gain after the Rate of 15 *per Cent.* Then to find how he must sell them *per* Piece, I say,

As 86 Pieces are to 148*l.* 7*s.* so is 1 Piece to 1*l.* 14*s.* 6*d.* which is the Number sought.

Quest. 5 A Grocer bought $4\frac{1}{4}$*C.* of Pepper for 15*l.* 17*s.* 4*d* and (it proving to be damnified) is willing to lose 12*l.* 10*s.* *per Cent.* I demand how he must sell it *per* ℔?

Answer 7*d.* *per* ℔.

Subtract 12*l.* 10*s.* the Loss of 100*l.* from 100*l.* and there remains 87*l.* 10*s* Then say,

As 100*l.* is to 87*l.* 10*s.* so is 15*l.* 17*s.* 4*d.* to 13*l.* 17*s.* 8*d.* and so much he must sell it all for, to lose after the Rate propounded. Then to know how he must sell it *per* ℔ I say,

As $4\frac{1}{4}$*C.* is to 13*l* 17*s.* 6*d.* so is 1℔ to 7*d.*

Quest. 6. A Plummer sold 10 Fodder of Lead (the Fodder containing $19\frac{1}{2}$*C.* for 204*l.* 15*s.* and gained after the Rate of 12*l.* 10*s.* *per* 100*l.* I demand how much it cost him *per C.*?

Answer 18*s.* 8*d.*

To resolve this Question, add 12*l.* 10*s.* (the Gain *per Cent.* to 100*l.* and it makes 112*l.* 10*s.* Then say,

As 112*l.* 10*s.* is to 100*l.* so is 204*l.* 15*s.* to 182*l.* which 182*l.* is the Sum it cost him in all; then reduce your 10 Fodders to Half Hundreds, and it makes 390. Then say,

As

As 390 Half Hundreds is to 182*l*. so is 2 Half Hundreds to 18*s*. 8*d*. the Price of 2 Half Hundreds, or 1*Cwt*. and so much it stood him in *per C.wt*.

Quest. 7. A Merchant bought eight Tuns of Wine, which, being sophisticated, he selleth for 400*l*. and loseth after the Rate of 12*l*. in receiving 100*l*. Now I demand how much it cost him *per* Tun, and how he selleth it *per* Gallon to lose after the said Rate?

Answer. It cost him 56*l*. *per* Tun, and he must sell it at 3*s*. 11*d* $\frac{10}{21}$*qrs*. *per* Gallon, to lose 12*l*. in receiving 100*l*.

To resolve this Question, I consider, in the first Place, that in receiving 100*l*. he loseth 12*l* therefore 100*l*. comes in for 112*l*. laid out; wherefore, to find out how much he laid out for the whole, I say,

As 100*l*. is to 112*l*. so is 400 to 448*l*. and so much the 8 Tun cost him: Then to find out how much it cost *per* Tun, I say,

As 8 is to 448*l*. so is 1 to 56*l*. the Price it cost *per* Tun.

Now to find how he must sell it *per* Gallon, reduce the 8 Tuns into Gallons, they make 2016. Then say,

As 2016 Gallons is to 400*l*. so is 1 Gallon to 3*s*. 11*d*. $2\frac{15}{28}$*qrs* the Price he must sell it at *per* Gallon to lose as aforesaid.

Quest. 8. A Merchant bought 8 Tun of Wine, which being sophisticated he is willing to sell for 400*l*. and loseth at that Rate 12*l*. in laying out 100*l*. upon the same; now I demand how much it cost him *per* Tun?

Here I consider, that for 100*l*. laid out he received but 88*l*. wherefore to find what 8 Tuns cost him, I say,

As 88*l*. is to 100*l*. so is 400*l* to $454\frac{5}{11}$, the Price it all cost him: Then to find out how much *per* Tun, I say,

As 8 is to $454\frac{5}{11}$, so is 1 to $56\frac{9}{11}$, or 56*l*. 16*s*. 4*d*. $1\frac{5}{11}$*qrs*. *per* Tun.

CHAP. XXIX.

Equation of Payments.

1 EQUATION of Payments, is that Rule among Merchants, whereby we reduce the Times for Payment of several Sums of Money, to an equated Time for Payment of the whole Debt, without Damage to Debtor or Creditor; and

The

The Rule is,

2. Multiply the Sums of each particular Payment by its respective Time, then add the several Products together, and their Sum divide by the total Debt, and the Quotient thence arising is the equated Time for the Payment of the whole Debt.

Example.

Quest. 1. *A* is indebted to *B* in the Sum of 130*l.* whereof 50 is to be paid at 2 Months, and 50*l.* at 4 Months, and the rest at 6 Months; now they agree to make one Payment of the total Sum: The Question is, what is the equated Time for Payment, without Damage to Debtor or Creditor?

To resolve this Question, I multiply each Payment by its Time, *viz.*

50*l.* multiplied by 2 Months produceth	100
50*l.* multiplied by 4 Months produceth	200
30*l.* multiplied by 6 Months produceth	180
The Sum of the Product is	480

Then I divide 480 (the Sum of the Products) by 130 (the total Debt) and the Quotient is $3\frac{9}{13}$ Months for the Time of paying the whole Debt.

Quest. 2. A Merchant hath owing to him 1000*l.* to be paid as followeth, *viz.* 600*l.* at 4 Months, 200*l.* at 6 Months, and the rest (which is 200*l.*) at 12 Months, and he agreeth with the Debtor to make one Payment of the whole; I demand the Time of Payment without Damage to Debtor or Creditor?

600*l.* multiplied by 4 Months is	2400
200*l.* multiplied by 6 Months is	1200
200*l.* multiplied by 12 Months is	2400
The Sum of the Products is	6000

and the Sum of the Products (6000) being divided by the whole Debt (1000*l.* quotes 6 Months for the Time or Payment of the whole Debt.

The Proof of the Rule of Equation of Payments.

3. The Truth of the Rule is thus manifest, if the Interest of that Money which is paid by the equated Time (after it is due) be equal to the Interest of that Money which (by the equated Time) is paid so much sooner than it is due at any rate *per Cent.* then the Operation is true, otherwise not.

Example.

Example.

In the last Question 600*l.* should have been paid at 4 Months, but it is not discharged till 6 Months (that is 2 Months after it is all due) wherefore its Interest for 2 Months at 6 *per cent. per annum* is 6*l.* and then 200*l.* was to be paid at 6 Months, which is the equated Time for its Payment, therefore no Interest is reckoned for it, but 200*l* should should have been paid at 12 Months, but is paid at 6 Months, which is 7 Months sooner than it ought, wherefore the Interest of 200*l.* for 6 Months is 6*l.* (accounting 6*l. per Cent. per Annum*) which is equal to the Interest of 600*l.* for 2 Months, wherefore the Work is right.

Quest. 3. A Merchant hath owing him a certain Sum to be discharged at three equal Payments, *viz.* $\frac{1}{3}$ at two Months, $\frac{1}{3}$ at four Months, and $\frac{1}{3}$ at eight Months; the Question is, what is the equated Time for the Payment of the whole Debt?

In Questions of this Nature (*viz.*) where the Debt is divided into unequal Parts) each of its Parts is to be multiplied by its Time, and the Sum of the Product is the Answer.

$\frac{1}{3}$ multiplied by 2 Months produceth	$\frac{2}{3}$
$\frac{1}{3}$ multiplied by 4 Months produceth	$1\frac{1}{3}$
$\frac{1}{3}$ multiplied by 8 Months produceth	$2\frac{2}{3}$
The Sum of the Product is	$4\frac{2}{3}$

which is $4\frac{2}{3}$ Months for the equated Time of Payment.

If instead of the Fractions representing the Parts, you had wrought by the Numbers themselves (represented by those Parts) according to the first and second Example, it would have been the same Answer; and suppose the Debt had been 90*l.* then $\frac{1}{3}$ of it is 30*l.* for each Payment, *viz.* at 2, 4 and 8 Months,

30*l.* multiplied by 2 Months produceth	60
30*l.* multiplied by 4 Months produceth	120
30*l.* multiplied by 8 Months produceth	240
The Sum of the Products is	420

which divided by 90 (the whole Debt) quoteth $4\frac{60}{90}$, or $4\frac{2}{3}$ Months, as before.

Quest. 4. A Merchant oweth a Sum of Money to be paid $\frac{1}{2}$ at 5 Months, and $\frac{1}{4}$ at 8 Months, and $\frac{1}{4}$ at 10 Months, and

and he agreeth with his Creditor to make one total Payment; I demand the Time without Damage to Debtor or Creditor? Work as in the last Question, and you will find the Answer to be 7 Months.

Quest. 5. *A* is indebted to *B* 640*l.* whereof he is to pay 40*l.* present Money, 350*l.* at 3 Months, and the rest, *viz.* 250*l.* at 8 Months, and they agree to make an equated Time for the whole Payment; now I demand the Time?

In Questions of this Nature (*viz.* where there is ready Money paid) you are, in multiplying, to neglect the Money that is to be paid present, and work with the rest, as is before directed, and divide the Sum of the Products by the whole Debt, and the Quote is the Answer; for here 40*l.* is to be paid present, and hath no Time allowed; and according to the Rule it should be multiplied by its Time, which is 0; therefore 40 times 0 is 0, which neither augmenteth nor diminisheth the Dividend; wherefore to proceed (according to Direction) I say,

350 by 3 Months produceth	1050
250 by 8 Months produceth	2000
The Sum of the Product is	3050

which divided by 640, the whole Debt, the Quote is $4\frac{49}{64}$ Months, the Time of Payment.

Quest. 6. *A* is indebted to *B* in a certain Sum, half whereof is to be paid present Money, $\frac{1}{3}$ at 6 Months, and the rest at 8 Months; now I demand the equated Time for Payment of it all?

Answer $3\frac{1}{3}$ Months is the Time of Payment.

Quest. 7. *A* is indebted to *B* 120*l.* whereof $\frac{1}{3}$ is to be paid at 3 Months, $\frac{1}{4}$ at 6 Months, and the rest at 9 Months; what is the equated Time for payment of the whole Sum?

Answer at $6\frac{1}{4}$ Months.

Quest. 8. *A* is indebted to *B* 420*l.* which is due at the End of 6 Months, but *A* is willing to pay him 140*l.* present, provided he can have the Remainder forborn so much the longer, to make Satisfaction for his Kindness, which is agreed upon; I desire to know what Time ought to be allotted for the Payment of the 280*l.* remaining?

The Operation of this Question is left to the Learner, to try his Genius, and who, in this Case, must have an Eye to the Rule of Three.

CHAP.

CHAP. XXX.

Exchange.

1. THE Rule of *Exchange* informeth the Merchants how to exchange Monies, Weights or Measures of our Country into (or for) the Monies, Weights or Measures of another Country, and when the Rate, Reason or Proportion betwixt the Money, Weights or Measures of different Countries is known, it will not be difficult for the Practitioner that is well acquainted with the Rule of Proportion (or *Rule of Three*) to resolve any Question, wherein it is required to exchange a given Quantity of the one Kind into the same Value of another Kind.

2. In Questions of Exchange there is always a Comparison made between the two Coins, *&c.* of two Countries (or Kinds) or of more.

2. In Questions where there is a Comparison made between two Things (whether they be Monies, Weights, *&c.*) of different Kinds, there may be a Solution found by a single Rule of Three, as by the following Example.

Quest. 1. A Merchant at *London* delivered 370*l. sterl.* to receive the same at *Paris* in *French* Crowns, the Exchange $3\frac{1}{3}$ *French* Crowns *per l. sterling*; I demand how many *French* Crowns he ought to receive?

In placing the Numbers, observe the 6th Rule of the 10th Chapter, which being done, the given Number will stand thus:

l.	*Crowns*	*l.*
1	$3\frac{1}{3}$	370

and being reduced according to the Rules of the 24th Chapter, will stand thus:

As $\frac{1}{1}$ is to $\frac{10}{3}$, so is $\frac{370}{1}$ to $1233\frac{1}{3}$.

So that I conclude he ought to receive $1233\frac{1}{3}$ *French* Crowns at *Paris* for his 370*l* deliver'd at *London*.

Quest. 2. A Merchant deliver'd at *Amsterdam* 587*l. Flemish*, to receive the Value thereof at *Naples* in Ducats, the Exchange $4\frac{4}{5}$ Ducats *per l. Flemish*; I demand how many Ducats he ought to receive?

The Proportion is as followeth:

l.		*Ducats*		*l.*		*Ducats*
As $\frac{1}{1}$	is to	$\frac{24}{5}$,	so is	$\frac{587}{1}$	to	$2817\frac{3}{5}$

So

So I find he ought to receive $2817\frac{3}{5}$ Ducats at *Naples*, for the 587*l.* *Flemish* delivered at *Amsterdam*.

Quest. 3. A Merchant at *Florence* delivereth 3478 Ducatoons, to receive the Value at *London* in Pence, the Exchange at $53\frac{1}{2}$*d.* *sterling per* Ducatoon; I demand how much *sterling* he ought to receive?

The Proportion for Resolution is,

Ducats *d.* *Ducats* *d.*

As $\frac{1}{1}$ is to $\frac{107}{2}$, so is $\frac{3478}{1}$ to 186073

which is equal to 775*l* 6*s* 1*d* for the Answer.

4. When there is a Comparison made between more than two different Coins, Weights or Measures, there ariseth ordinarily two different Cases from such a Comparison.

1. When it is required to know how many Pieces of the first Coin, Weight or Measure are equal in Value to a known Number of Pieces of the last Coin, Weight or Measure.

2. When it is required to find out how many Pieces of the last Coin, Weight or Measure are equal in Value to a given Number of the first sort of Coin, Weight or Measure.

An Example of the first Case may be this, *viz.*

Quest. 4. If 150 pence at *London* are equal to 3 Ducats at *Naples*, and $4\frac{4}{5}$ Ducats at *Naples* make $34\frac{1}{2}$ Shillings at *Brussels*? then how many pence at *London* are equal to 138*s.* at *Brussels*? *facit* 960*d.*

The Question may be resolved by two single Rules of Three: For first, I say,

If $\frac{3}{1}$ Ducats at *Naples* make 150*d* at *London*, how many pence will $4\frac{4}{5}$ Ducats make? *Answer* 240*d.*

By the foregoing proportion we have discovered, that $4\frac{4}{5}$ Ducats at *Naples* make 240 pence at *London*; and by the Tenor of the Question we see, that $4\frac{4}{5}$ Ducats at *Venice* make $34\frac{1}{2}$ Shillings at *Brussels*; therefore 240*d.* at *London* are equal to $34\frac{1}{2}$*s.* at *Brussels* (for the Things that are equal to one and the same Thing, are also equal to one another) wherefore we have a Way laid open to give a Solution to this Question by another single Rule of Three, whose proportion is.

As $34\frac{1}{2}$*s.* at *Brussels* is to 240*d.* at *London*, so is 138*s.* at *Brussels* to 960*d.* at *London*; which is the Answer to the second Question.

An Example of the second Case may be this, *viz.*

Quest.

Quest. 5. If 40lb *Averdupois-weight* at *London* is equal to 36lb weight at *Amsterdam*, and 90lb at *Amsterdam* makes 116lb at *Dantzick*; then how many Pounds at *Dantzick* are equal to 112lb *Averdupois-weight* at *London*?

Answer $129\frac{23}{25}$lb at *Dantzick*.

This Question is likewise answered by two single Rules of Three, *viz.* First, I say,

As 36lb at *Amsterdam* is to 40lb at *London*,

So is 90lb at *Amsterdam* to 100lb at *London*.

And by the Question you find, that 90lb at *Amsterdam* is 116lb at *Dantzick*, and therefore 100lb at *London* is likewise equal thereunto; wherefore again I say,

As 100lb at *London* is to 116lb at *Dantzick*.

So is 112lb at *London* to $129\frac{23}{25}$lb at *Dantzick*.

By which I find, that $129\frac{23}{25}$lb at *Dantzick* are equal to 112lb *Averdupois-weight* at *London*.

5. There is a more speedy Way to resolve such Questions as are contained under the two Cases before-mentioned, laid down by Mr. *Kersey* in the third Chapter of his Appendix to *Wingate*'s Arithmetick, where he hath given two Rules for the Resolution of the Questions pertinent to the said Cases.

6. But I shall lay down a general Rule for the Solution of both Cases; and 1st, Let the Learner observe the following Directions in placing of the given Terms, *viz.*

7. Let there be made 2 Columns, and in these Columns so place the given Terms one over the other as that in the same Column there may not be found 2 Terms of the same Kind one with the other.

Having thus placed the Terms, the general Rule is,

Observe which of the said Columns hath the most Terms placed in it, and multiply all the Terms therein continually, and place the last Product for a Dividend; then multiply the Terms in the other Column continually, and let the last Product be a Divisor; then divide the said Dividend by the said Divisor, and the Quotient thence arising will be the Answer to the Question.

So the Example of the first of the said Cases being again repeated, *viz.* if 150 pence at *London* make 3 Ducats at *Naples*, and $4\frac{4}{5}$ Ducats at *Naples* make $34\frac{1}{2}$ Shillings at *Brussels*, then how many Pence at *London* are equal to 138 Shillings at *Brussels*?

The Terms being placed according to the 7th Rule will stand as followeth:

Pence

	A	B	
Pence at *London.*	150	3	Ducats at *Naples.*
Ducats at *Naples.*	$4\frac{4}{5}$	$34\frac{1}{2}$	Shillings at *Brussels.*
Shillings at *Bruss*	138		

Having thus placed the Terms that in neither Column there are not two Terms of one Kind, then observe that the Column under A hath most Terms in it, therefore they must be multiplied together for a Dividend, *viz.* 150 multiplied by $4\frac{4}{5}$ produceth $\frac{3600}{5}$, which multiplied by 138 produceth $\frac{456800}{5}$ for a Dividend; then in the Column under B there are 3 and $34\frac{1}{2}$ which multiplied together produce $\frac{207}{2}$ for a Divisor; then having divided $\frac{45600}{5}$ by $\frac{207}{2}$, the Quotient is 960 pence for the Answer, as before.

Again, Let the Example of the second Case be again repeated, *viz.* if 40 ℔ *Averdupois weight* at *London* make 36 ℔ weight at *Amsterdam*, and 90 ℔ at *Amsterdam* make 116 ℔ at *Dantzick*, then how many Pounds at *Dantzick* are equal to 112 ℔ *Averdupois weight* at *London*.

The Terms being disposed according to the 7th Rule foregoing, will stand thus:

	A	B	
℔ at *London*	40	36	℔ at *Amsterdam.*
℔ at *Amsterdam*	90	116	℔ at *Dantzick.*
		112	℔ at *London.*

Whereby I find that the Terms under B multiplied together produce 467712 for a Dividend, and the Terms under A, *viz.* 40 and 90, produce 3600 for a Divisor, and Division being finished, the Quotient giveth $129\frac{3312}{3600}$ ℔ at *Dantzick* for the Answer.

CHAP. XXXI.

Single Position.

1. NEgative Arithmetick, called the *Rule of False*, is that by which we find out a Truth, by Numbers invented or supposed, either single or double.

2. The Rule of Single Position is, when at once, *viz.* by one false position, or feigned Number, we find out the true Number sought.

3. In

3. In the *Single Rule of False*, when you have made choice of your position, work it according to the Tenor of the Question, as if it were the true Number sought; and if by the ordering your position you find either the Result too much or too little, you may then find out the Number sought by this proportion following, *viz.*

As the Result of your position is to the position, so is the given Number to the Number sought.

Example.

Quest. 1. A Person having about him a certain Number of Crowns, said, if a 4th, 3d and 6th of them were added together they would make just 45 Crowns; now I demand the Number of Crowns he had about him?

Answer 60 Crowns.

To resolve this Question, I suppose he had 24 Crowns (or any other Number that will admit of the like Division) now the 4th of 24 is 6, and the 3d is 8, and the 6th is 4, all which parts (6, 8 and 4) being added together, make but 18, but it should be 45, wherefore I say, by the *Rule of Three.*

As 18 the Sum of the Parts is to the Position 24, so is 45 the given Number to 60 the true Number sought.

For the 4th of 60 is 15, and the 3d of 60 is 20, and the 6th of 60 is 10, which added together make 45.

CHAP. XXXII.

Double Position.

1. THE Rule of *Double Position* is, when two false Positions are assumed to give a Resolution to the Question propounded.

a X b
d   c

2. When any Question is stated in *Double Position*, make such a Cross as in the Margent.

3. Then make choice of any Number you think may be convenient for your working, which call your first position, and place it at the End of the Cross at *a*; then work with this position as if it were the true Number sought, according to the Nature of your Question; then having found out your Error, either too much or too little, place it on that Side the Cross at *d*, then make choice of another Number, of the same Denomination with the first position (which call your second position) and place it

it on the Side of the Crofs at *b*; then work with this position as with the former, and having found out your Error, either too much or too little, place it on that Side of the Crofs at *c*, and then the positions will ftand at the Top of the Crofs, and the Errors at the Bottom, each under his correfpondent position, and then multiply the Errors into the position crofs wife, that is, multiply the firft position by the fecond Error, and the fecond position by the firft Error, and put each Product over its position.

4. Having proceeded fo far, then confider whether the Errors are both alike, that is, whether they are both too much, or both too little; and if they are alike, then fubtract the leffer Product from the greater, and fet the Remainder for a Dividend; then fubtract the leffer Error from the greater, and let the Remainder be a Divifor, and the Quotient arifing by this Divifion is the Anfwer to the Queftion.

5. But if the Errors are unlike, that is, one too much and the other too little, then add the Products of the pofitions and Errors together, and their Sum fhall be a Dividend; then add the Errors together, and their Sum fhall be a Divifor, and the Quotient arifing hence is the Anfwer.

Queft. 1. *A*, *B* and *C* built a Houfe which coft 76*l.* of which *A* paid a certain Sum unknown, *B* paid as much as *A* and 10*l.* over, and *C* as much as *A* and *B*; now I defire to know each Man's Share in that Charge?

Having made a Crofs, according to the fecond Rule, I come according to the third Rule to make choice of my firft pofition, and here I fuppofe *A* paid 6*l.* which I put upon the Crofs as you fee, then *B* paid 16*l.* (for it's faid he paid 10*l.* more than *A*) and *C* paid 22*l.* (for it's faid he paid as much as *A* and *B*) then I add their parts.

l.		*l.*
9		*A* 6
19		*B* 16
28	120 168 288	*C* 22
——	16 X 9	——
56	12) (14	Sum 44
	32 20	
76	12	76
56		44
——		——
20		Error 32

and

and they amount to 44; but it is said they paid 76*l.* wherefore there is 32 too little, which I note down at the Bottom of the Cross under its Position for the first Error.

2dly, I suppose *A* paid 9*l.* then *B* paid 19*l.* and *C* 28*l.* all which added together make 56, but they should make 76, wherefore the Error of this Position is 20, which I put at the Bottom of the Cross under its Position for the second Error; then I multiply the Errors and Position crosswise, *viz.* 32 (the Error of the first Position) by 9 (the second Position) and the Product is 288; then I multiply 20 (the Error of the second Position) by 6 (the first Position) and the Product is 120.

Then (according to the 4th Rule) I subtract the lesser Product from the greater, *viz.* 120 from 288, because the Errors are both alike, (*viz.* too little) and there remaineth 168 for a Dividend; then I subtract 22 (the lesser Error) from 32 (the greater Error) and the Remainder is 12 for a Divisor; then I divide 168 by 12, and the Quotient is 14 for the Answer, which is the Share of *A* in the Payment.

6. Again, 2dly, if the Errors had been both too big, it had the same Effect, as appeareth by the following Work; for first, I suppose *A* paid 20*l.* then *B* paid 30*l.* and *C* 50*l.* which in all is 100*l.* but it should have been no more than 76, wherefore the first Error is 24 too much. Again, I suppose *A* paid 18*l.* then *B* must pay 28*l.* and *C* must pay 46*l.* which in all is 92*l.* but it should have been but 76.

20 *A*				*A* 18
30 *B*				*B* 28
50 *C*	320	112	432	*C* 46
	20	X	18	
100 Sum	8)		(14	Sum 92
76 Subtract	24		16	Subtract 76
		8		
24 Error				Error 16

wherefore the 2d Error is 16 too much; then I multiply 20 (the first Position) by 16 (the 2d Error) and the Product is 320. Again, I multiply 18 (the 2d Position) by 24 (the first Error) and the Product is 432. Then, because the Errors are both too much, I subtract 320 (the lesser Product) from 432 (the greater Product) and there remaineth 112 for a Dividend; likewise I subtract 16 (the lesser Error) from

from 24 (the greater Error) and the Difference is 8 for a Divisor; then perform Division, and the Quotient is 14, as before, for the Answer.

Again, 3dly, if the Errors had been the one too big and the other too little, Respect being had to the fifth Rule foregoing, the Answer would have been the same, as thus, I take for my first Position 6, and then the Error is 32 too little; then I take for my second Position 18, and then the Error is 16 too much; then I multiply the Positions and Errors cross-wise, and the Products are 96 and 576, and because the Errors are unlike, *viz.* one too big and another too little, I add the Products 96 and 576 together, and their Sum is 672 for a Dividend; I likewise add the Errors 32 and 16 together, and their Sum is 48 for a Divisor; then having finished Division, I find the Quotient to be 14, which is the Answer, as was found out at the two several Trials before.

96	672	576
6	X	18
48)		(14
32		16
	48	

For Proof of this Work, I say,

	l.
If *A* paid — —	14
Then *B* paid 14 and 10 (that is)	24
Then *C* paid 14 and 24 (that is)	38
The Sum of all is	76

which is the total Value of the Building, and equal to the given Number.

Those who desire to see the Demonstration of this Rule, let them read the 7th Chapter of Mr. *Kersey*'s Appendix to Mr. *Wingate*'s Arithmetick, *Pitiscus* in the 5th Book of his *Trigonometria,* or Mr. *Oughtred* in his *Clavis Mathematica.*

Quest. 2. Three Persons, *A*, *B* and *C*, thus discoursed together concerning their Age; quoth *A*, I am 18 Years of Age; quoth *B*, I am as old as *A* and half *C*; and quoth *C*, I am as old as you both, if your Years were added together; now I desire to know the Age of each Person?

Answer A is 18, *B* is 54, and *C* is 72 Years of Age.

Quest. 3. A Father lying at the point of Death, left to his three Sons, *viz* *A*, *B* and *C*, all his Estate in Money, and divided it as followeth, *viz.* to *A* he gave half, wanting 44*l.* to *B* he gave $\frac{1}{3}$ and 14*l.* over, and

to

to *C* he gave the Remainder, which was 82*l.* leſs than the Share of *B*; now I demand what was the Sum left, and each Man's Part?

Anſwer. The Sum bequeathed was 588*l.* whereof *A* had 250*l.* *B* had 210*l.* and *C* had 128*l.*

Queſt. 4. Two Perſons, *viz.* *A* and *B*, had each in their Hands a certain Number of Crowns, and *A* ſaid to *B*, if you give me one of your Crowns, I ſhall have five times as many as you; and ſaid *B* to him again, if you give me one of yours, then we ſhall each of us have an equal Number; now I demand how many Crowns had each Perſon?

Anſwer, A had 4, and *B* had 2 Crowns.

Queſt. 5. What Number is that unto which if I add $\frac{1}{4}$ of itſelf, and from the Sum ſubtract $\frac{1}{8}$ of itſelf, the Remainder will be 216?

Anſwer 192.

Many more Queſtions may be added, but theſe well underſtood will be ſufficient (even for the meaneſt Capacity) for the Reſolution of any other Queſtion pertinent to this Rule.

There may be an Objection made, becauſe we have not treated particularly upon Intereſt and Rebate; but the Operation of ſuch Queſtions being more applicable to Decimals, are omitted, till we come to acquaint the Learner therewith.

LAUS DEO SOLI.

FINIS.